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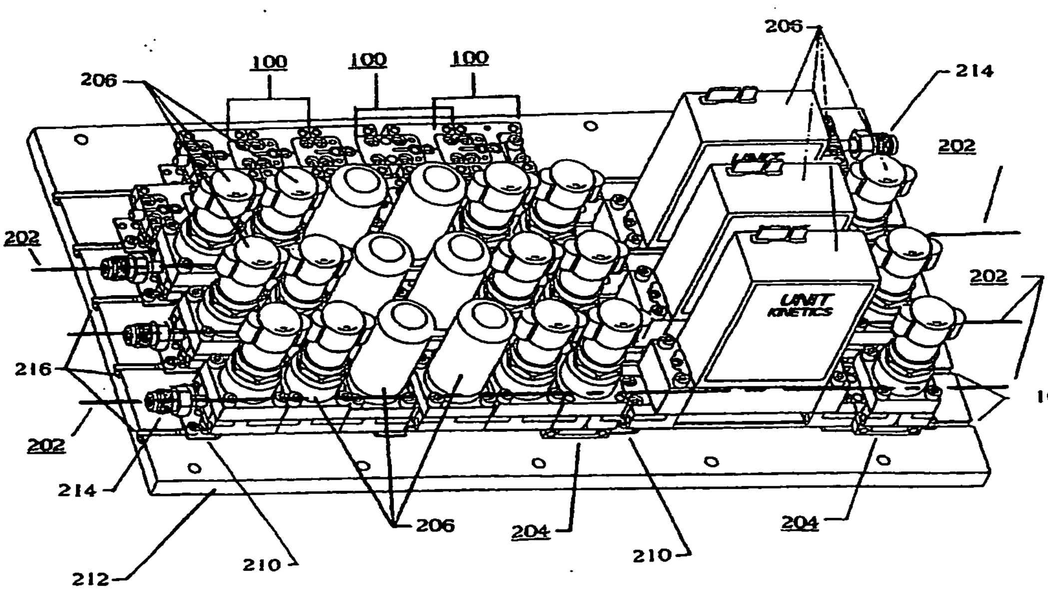
(54) Title: SYSTEM OF MODULAR SUBSTRATES FOR ENABLING THE DISTRIBUTION OF PROCESS FLUIDS THROUGH REMOVABLE COMPONENTS



(57) Abstract: A fluid panel subassembly comprising, a component; a substrate seal, a body, and an insert; wherein the body is fastened to the insert to form a substrate with the substrate seal therein, and the component is fastened to the body such that, the component is positioned over the substrate seal.

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SYSTEM OF MODULAR SUBSTRATES FOR ENABLING THE DISTRIBUTION OF PROCESS FLUIDS THROUGH REMOVABLE COMPONENTS

Background of the Invention

1. Field of the Invention

The present invention is directed to a modular system for enabling a distribution of fluids, and more particularly to a system that enables a distribution of gases in a semiconductor manufacturing environment.

2. Description of Related Art

Fluid transfer panels are used to control the flow of fluids and fluid mixtures in many manufacturing processes and machinery. In the area of semiconductor manufacturing, wafer fabrication facilities are commonly organized to include areas in which chemical vapor deposition, plasma deposition, plasma etching, sputtering and the like are carried out. In order to carry out these processes, it is necessary for the tools and machines that are used for the processes to be provided with a precise amount of processing gases to enable the fabrication steps. In a typical wafer processing facility, inert and reactant gases are stored in tanks which may be located a distance from the wafer processing area and are connected via piping or conduit ultimately to a gas panel. The gas panel has the purpose of delivering precisely metered amounts of pure inert or reactant gas. A typical gas panel includes a plurality of gas paths having connected therein literally hundreds of components, such as valves, filters, flow regulators, pressure regulators, pressure transducers, and connections, connected together by tens (or hundreds) of feet of tubing. Gas panels are designed to provide desired functions, such as gas transport, mixing and purging, by uniquely configuring the various individual components.

The gas panel occupies a relatively large amount of space, as each of the components are plumbed into the gas panel, either through welding tubing to the devices or combinations of welds and connectors.

Gas panels are difficult to manufacture and hence expensive. Welds are relatively expensive to make in such systems as they must take place in an inert atmosphere. The surfaces of the gas handling system that contact gas must be made as smooth and nonreactive as possible in order to reduce the number of sites where contaminants may tend to deposit in

the tube, leading to the formation of particulates or dust which could contaminate the wafers being processed.

Additional problems with the conventional gas panels relate to the fact that such a welded system of the type currently used today requires a significant amount of space between each of the components so that during servicing the connections can be accessed and opened. In addition, in order to remove a section or portion of a contemporary gas panel, many of the supports of the surrounding parts must be loosened so that the hardware can be spread out to allow removal of the item under consideration.

Summary

A fluid panel subassembly comprising: a component; a substrate seal, a body, and an insert; wherein the body is fastened to the insert to form a substrate with the substrate seal therein, and the component is fastened to the body such that, the component is positioned over the substrate seal.

Brief Description of the Drawings

Figure 1 is an illustration of a series of sticks on a structural support;

Figure 2a is a cross-section of a stick;

Figure 2b is an end view of a stick providing a cross-section of a manifold assembly;

Figure 3 is a top view of a flow-through body;

Figure 4 is a cross-section of an MFC body;

Figure 5a is a cross-section of an interconnecting body;

Figure 5b is an end-view of an interconnecting body;

Figure 6a is an end view of a multi-flow body;

Figure 6b is a cross-section of a multi-flow body;

Figure 7a is a top view of a single-branch insert;

Figure 7b is a cross-section of a single-branch insert;

Figure 8a is a top view of a dual-branch insert;

Figure 8b is a cross-section of a dual-branch insert;

Figure 9a is a top view of a first substrate;

Figure 9b is a cross-section of a first substrate;

Figure 10 is an illustration of an MFC substrate;

Figure 11a is a cross-section of a second substrate;

Figure 11b is an illustration of a second substrate with a closed valve:

Figure 11c is an illustration of a second substrate with an open valve;

Figure 12a is an illustration of a third substrate;

Figure 12b is an illustration of a third substrate with a closed valve;

Figure 12c is an illustration of a third substrate with an open valve;

Figure 13 is an exploded view of substrates and a component;

Figure 14a is a top view of components outlined over substrates;

Figure 14b is a cross-section showing gas flow through substrates and components;

Figure 15a is an illustration of at body, art extension, and an insert assembly;

Figure 15c is an illustration of an extension;

Figure 16 is an illustration of a plug insert;

Figure 17 illustrates a tube weld insert and an inlet/outlet fitting;

Figure 18 is an exploded view of a body, heat conductive sleeves, and cartridge heaters;

Figure 19 is a cross-section of a manifold assembly;

Figure 20a is an illustration of a U-shaped fluid panel;

Figure 20b is a cross-section of a U-shaped fluid panel;

Figure 21a is an illustration of an L-shaped fluid panel;

Figure 21b is an illustration of an L-shaped fluid panel;

Figure 22 is an illustration of bodies and inserts;

Figure 23 is an illustration of various blocks displaying flow markings.

A Detailed Description of A Preferred Embodiment

Modern IC chip producers have improved the efficiency of their products by processing more semiconductors on wafers of a larger diameter such as 300 mm size wafers. Such design goals, always evolving, have placed continued demands on process toolmakers to minimize the size of fabrication equipment since workspace for the process tools is at a premium. There also exists the desire to increase reliability and reduce repair time both of which will decrease downtime. The present invention relates to a subassembly of a wafer processing system, the gas delivery system. However, it should be appreciated that the present invention can be applied to a variety of uses for channeling fluids ranging from

liquids to gases, including corrosive materials, and processing such over a wide range of temperatures.

In a preferred embodiment, the delivery system is a gas panel assembly. This assembly begins with a gas input that passes through a series of components that regulate flow, regulate or measure pressure, add valves, and filters. Referring to Figure 1, these components are placed in series with a variety of modular blocks pre-assembled into component substrates that connect the output of a first component to the input of a next component. This array of components and connectors is called a stick and a plurality of sticks are positioned adjacent to each other with each stick being provided a particular gas. Another series of modular substrates, known as manifold substrates connect to form manifold assemblies (manifolds) 204 and mix flow between the various sticks 202. This series of connections between components of a stick and between the plurality of sticks comprises a gas panel.

Referring to Figures 2a and 2b, when the preferred embodiment is complete, the plurality of components, substrates, and blocks that make up a gas panel will form four layers of items. A top layer or first level is made up of the components 206 such as: filters, valves, flow regulators, pressure regulators, and pressure transducers. A second layer, the component substrate layer, is beneath the first component layer and involves a series of component substrates 100 that connect to provide Row paths to transfer gasses along a stick 202 by channeling flow in and out of each component 206. A third layer, the manifold substrate layer (manifold assembly or manifold 204), is comprised of building blocks similar to the second layer that are pre-assembled into substrates 100 and connect to transfer process gasses between sticks 202. A fourth layer is composed of a support structure for mounting the gas panel, shown here as a mounting plate 212 which is connected to the second layer through the use of brackets 2 10. The present invention allows for the interconnecting of channel throughout the sticks and manifolds of a gas panel through the use of a few basic modular block designs that are pre-assembled into substrates. These different blocks are sufficient to meet all of the flow channeling requirements necessary in the gas panel. The present invention of modular blocks or substrates allows for access to the sticks and manifolds from the convenient top side of the gas panel and the easy addition of sticks 202 to existing manifolds 204. The present invention avoids most inconvenient fastening requirements by the end user, and provides for the use of industry standard interfaces and channel sizes.

Referring back to Figure 1, there is shown a key part to the present invention, the substrate 100, several of which are visible in two partial stick assemblies. Various types of substrates connect components 206 together (component substrates) as well as form manifold assemblies (manifold substrates) 204. Connections of substrates 100 running transverse to the sticks 202 form manifold assemblies 204 that: accept gas from a source, channel gas flow between sticks 202, or channel gas out of the sticks 202. Manifold assemblies 204 are connected to the component substrate level using different types of interconnecting blocks that can be used to make up the component substrate. In Figure 1, a gas inlet/outlet fitting 214 is visible near an end manifold assembly 204 and a plurality of inlet/outlet fittings 214 are visible at the opposite ends of assembled sticks 202. A mid-section manifold assembly 204 is visible under one component substrate 100 as are brackets 2 10 attached to the component substrate level and the mounting plate 212.

Turning now to Figures 2a & b, there is seen a cross-section of a stick 202 with component substrates 100 connecting the gas flow outputs of a series of components 206. The third layer makes use of substrates 100 to create manifold assemblies 204 that connect transversely to second layer substrates and provide gas flow interconnections between the plurality of sticks 202. The fourth layer acts as a support structure for the other layers. For the preferred embodiment, support is provided by the mounting plate 212 which has a series of dove-tail grooves 216 (Figures 1 & 2b) that attach to brackets 210, the brackets 210 further fasten to the underside of the component substrates or second layer.

In the preferred embodiment, the present invention begins with a connecting block known as a body which may be one of four designs, each one channeling flow differently. Referring to Figure 3, there is seen a top view of the first body design, a flow-through body 101 used to connect flow along a stick 202 (Figures 1 & 2a & b) or along a manifold assembly 204 (Figures 1 & 2a & b). In Figure 4 is illustrated an MFC (mass flow controller) body 103 used to connect mass flow controllers within a stick 202. Figures 5a & b shows another body design, an interconnecting body 201. An interconnecting body 201 connects flow between a stick 202 (Figures 1 & 2a & b) and a manifold 204 (Figures 1 & 2a and b). Figures 6a & b illustrate a multi-flow body 301 which both connects a stick 202 to a manifold 204 and flow along a stick 202. At the manufacturer or factory, the selected body 101, 103, 201, 301 is connected to a second type of building-block called an insert. This second building-block has two designs. The first insert design, as shown in Figures 7a & b, is a

single-branch insert 104 which channels flow between a component and a body or between a stick and a manifold (either a flow-through body 101 or a multi-flow body 301). The second insert design as shown in Figures 8a & b is a dual-branch insert 102 that provides channeling for flow only between the components 206.

Returning to Figure 3, the flow-through body 101 has the outer geometry of a block shape that is 1.5" L (long) X 1.5" W (wide) X 0.5" TK (thick). The flow-through body 101 is comprised of a top surface 159 and a first undercut (slot or cutout) 160 having a first back face 161 and a second undercut (slot) 162 having a second back face 163. Both undercuts (slots) 160, 162 are 0.5" L X 0.9" W X 0.38" DP. A 0.180" diameter (dia.) channel 152 is machined beginning at a first port 158 at the top surface 159 and transitions a net 90 degrees to a second port 169 at the first back face 161. Both ports 158, 169 are counterbored 0.29" dia. X 0.24" DP. The flow-through body 10 1 has 4 X 0.190" dia. X 0.26" DP threaded through holes (not shown). The first undercut 160 has 2 X 0.190" dia. threaded through holes 164. The first back face 161 has 2 X 0.170" dia. through holes 166 to the second back face 163. The channel 152 at the second port 169 is located equidistant between the two through holes 166. At the second back face 163, each through hole 166 is counterbored 0.28" dia. X 0.21" DP. In the second undercut 162 there exists 3 X 0.190" dia. threaded through holes 164. Running the length of either side of the body are 2 X 0.1875" dia. through holes used as heater channels 180.

The MFC body 103 is shown in Figure 4. The MFC body 103 has an outer shape of 0.95" L X 1.5" W X 0.50" TK. There is a top surface 450 and a cutout 454 with a backface 456. The undercut has the dimensions of 0.5"L X 0.9" W X 0.38" DP. A counterbore 453 exists in the back face 456 that is 0.29" dia" X 0.02 1 DP. Equidistant about the counterbore 453 are 2 X 0.70" dia. through holes 457 that start at a first end 455 and run out at the backface 456. The two holes 457 are counterbored 0.28" dia. X 0.16" DP at the first end 455.

Referring now to Figures 5a & b, there is illustrated the interconnecting body 201, used to connect flow between the manifold assemblies 204 and the sticks 202 (Figures 1 & 2a & b). The interconnecting body 201 has an outer geometry in a block shape that is 1.5" L X 1.5" W X 0.5" TK. The interconnecting body 201 has a top surface 408 and a bottom surface 412. The top surface 408 has a 0.180" dia. X 0.33" DP top channel 413 that exits at a port 414, the top channel 413 is normal to the top surface 408. The top surface 408 is flat and forms a plane. The interconnecting body 201 has 2 X 0.156" dia. through bottom channels

415, 417 with centerlines 419, 423 that exit at a bottom surface 412 at ports 416, 418. The two bottom channels 415, 417 are angled 60 degrees relative to the top surface 408 and counterbored 0.29" dia. X 0.024" DP at the bottom surface 412. The two bottom channels 415, 417 each includes a hemisphere 0.09" R (radius) 421 drilled within the ports 416, 418. The two bottom channel centerlines 419, 423 are spaced (0.30" apart at the bottom surface. Top surface 408 and bottom surface 412 are parallel to each other. The two ports 416, 418 at the bottom surface 412 are positioned equidistant about the top channel 413 centerline 411. The two bottom channels 415, 417 intersect the top channel 413 in mid-body 201. The interconnecting body 201 has a first undercut 424 and a second undercut 425. Both undercuts 424, 425 are 0.5" L X 0.9" W X 0.38" DP. The second undercut 425 has a backface 426 with a 0.29 dia. X 0.024 DP counterbore 428.

Referring now to Figures 6a & b, there is illustrated the multi-flow body 301 used to connect flow both along the sticks 202 and between the manifold assemblies 204 and the sticks 202 (Figures 1 & 2a & b). The multi-flow body 301 has an outer geometry in a block shape that is 1.5" L (long) X 1.5" W (wide) X 0.5" M. The multi-flow body 301 has a top surface 422 and a bottom surface 420. A 0.180" diameter top channel 430 with a 0.29 dia. X 0.024 DP counterbore, begins at a top port 436 that is centered in the top surface 422, 2 X 0.180" bottom channels 438, 439 each having 0.29" dia. X 0.024" DP counterbores, exist at two bottom ports 431, 433 located at a bottom surface 420. The two bottom channels 438, 439 intercept the top channel 430 in mid-block 301. The multi-flow body 301 has a first undercut 435 and a second undercut 437. Both undercuts 435, 437 are 0.5" L X 0.9" W X 0.38" DP. A .180" diameter channel 432 counterbored 0.29 dia. X 0.030" DP begins at a port 434 of the second undercut 437, is normal to, and intersects channel 430 in mid-body 301.

Turning now to Figure 7a there is seen a top view, and Figure 7b a cross-section, of a single-branch insert 104. The single-branch insert 104 has the outer dimensions of a rectangular block, 1.4" L X 0.875" W X 0.375" TK. The single-branch insert 104 has a first end 176 which is later fastened to an undercut of one of the four bodies 101, 103, 201, 301 (Figures 3, 4, 5a & b, 6a & b) at the factory, and a second end 172 which is fastened to an undercut of a different substrate at final assembly. The single-branch insert 104 has a top surface 178 and a bottom surface 179. The single-branch insert 104 has a 0.180" dia. channel 166 therein, the channel 166 begins at a first port 177 located at the insert first end 176. The channel 166 runs the length of the single-branch insert 104 to a second port 182 located on

the top surface 178. First port 177 having a 0.29" dia. X 0.030" DP counterbore 175, and the second port 182 having a 0.29" dia. X .024" DP counterbore. The channel 166 completes a net or resultant 90-degree turn between the ports 177 & 182. The single-branch insert 104 includes 4 X 0.190" dia. through holes 184 counterbored 0.33 dia. X 0.20" DP. On opposite sides of the second port 182 art 2 X 0.12" dia. through holes 186. Two stainless steel pins 188, each 0.120/.121" dia. X 0.38" L are press-fit into the holes 186 such that 0.12" of the pins 188 extend out of the single-branch insert 104 bottom surface 179. Two (2) X 0.160" dia. threaded holes 190 exist equidistant about the first port 177 at the first end 176.

Turning now to Figure 8a there is seen a top view, and Figure 8b a cross-section, of a dual-branch insert 102. The dual-branch insert 102 has a first end 376 which is later fastened to an undercut of one of the four bodies 101, 103, 201, 301 (Figures 3, 4, 5a & b, 6a & b) at the factory, and a second end 372 which is fastened to an undercut of a different substrate at final assembly. The dual-branch insert 102 has the outer dimensions of a rectangular block, 1.4" L X 0.875" W X 0.375" TK. The dual-branch insert 102 has a top surface 378 and a bottom surface 379. The dual-branch insert 102 has a 0.180" dia. first channel 366 therein, the first channel 366 begins at a first port 377 located at the insert first end 376 and includes a counterbore 0.29" dia. X.021 DP. The first channel 366 runs the length of the dual-branch insert 102 to a second port 382 located on the top surface 378. The second port 382 has a 0.29" dia. X.024" DP counterbore. The first channel 366 completes a net or resultant 90-degree turn between the ports 377, 382. The dual-branch insert 102 includes 4 X 0.190" dia. through holes 384 counterbored 0.33" dia. X 0.20" DP. Equidistant about the second port 382 are 2 X 0.12" dia. through holes 387. Two stainless steel pins 188, each 0.120/0.121" dia. X 008" L are press-fit into the holes 387 such that 0.12" of the pins 188 extend out of the insert bottom surface 379. Two X 0.164" dia. threaded holes 390 exist equidistant about the first port 377 at the first end 376. Beginning at the top surface 378, near the first end 376, is a second channel 367 having a third port 386 which is counterbored 0.29" dia. X 0.024" DP. This channel is normal to the top surface 378 and intersects the first channel 366 in mid-body 102.

The present invention constructs substrates from two building blocks, the body 101, 103, 201, 301 and the insert 104, 102. Through body 101, 103, 201, 301 and insert 102, 104 selection, channeling can be provided to direct gas flow a variety of ways through the substrate. The assembly of the first substrate 100 will be described in detail but it is to be

understood that other substrates discussed later use the same assembly procedures and fasteners as the first substrate 100, and have common mating features to the insert the body, and the seal (discussed later) within.

Provided in Figure 9a is a top view and Figure 9b a cross-section showing the first type of substrate assembly or first substrate 100. A flow-through body 101 (Figure 3) is connected to a single-branch insert 104 (Figures 7a & B), to form the first substrate 100 which makes up portions of the second and third layers for interconnecting process gasses. This first substrate 100 may be used within a component substrate in which the flow-through body 101 has a set of hole patterns to connect to components 206 above or brackets 216 below. Alternatively, this first substrate 100 may be used in a manifold assembly 204 (Figures 1 & 2a & b) using a flow-through body 101 which has a different set of hole patterns for connecting to component substrates above. The first substrate 100, when connected to a gas panel system, will channel flow in a direction along a stick 202 or manifold assembly 204 (Figures 1 & 2a, b).

The first substrate 100, assembled from the flow-through body 101 and the single-branch insert 104, includes a metallic seal 155 at a common mating surface. This metallic seal 155 (Figure 9b) is crush seated at assembly. The first substrate 100, as with all substrate designs, is assembled by the manufacturer at the factory, the substrates are not intended for disassembly by unauthorized personnel, and the seal 155 is known as a factory seal. The selected body, here a flow-through body 101, and the single-branch insert 104 are connected using threaded fasteners 150, which provide a clamping force 153 (Figure 9a) to crush-seat and maintabin the metal seal 155 in position. The flow-through body 101 has undercuts 160, 162 (Figure 3a) for mating with or receiving the ends of single-branch inserts 104. One such single-branch insert 104 will be assembled to the flow-through body 101 undercut 160 with fasteners 150 at the factory and includes the factory seal 155. The other undercut 162 will connect to an insert 102, 104 of another substrate during assembly of a stick 202 (Figures 1 & 2a, b) or manifold assembly 204 (Figures 1 & 2a, b) by the end user.

The substrate 100 is assembled by fastening the flow-through body first undercut 160 to an insert first end 176. Within the substrate 100, between the flow-through body second port 169 common to the single-branch insert first port 177, is the factory seal 155. The seal 155 is maintained jai a seal joint 140 provided by a gap 140 between the flow-through body second port 169 counterbore and the insert first port 177 counterbore, the gap 140 being

created when the flow-through body 101 and the single-branch insert 104 are assembled. As shown in Figure 9b the combined flow-through body channel 152 and single-branch insert channel 166 provide a fluid flow path that transitions a net or resultant 180-degrees between the flow-through body first port 158 and the single-branch insert second port 182. Once the substrate 100 is assembled widi fasteners 150, the factory seal 155 will be maintained between the flow-through body 101 and the single-branch insert 104.

Turning to Figure 10, there is shown an MFC substrate 50. The MFC substrate 50 is assembled from an MFC body 103 (Figure 4), a single-branch insert 104 (Figure 7) or as shown a dual-branch insert 102 (Figure 8), and a seal 155. The MFC substrate 50 is used to connect MFCs 206 into a stick assembly 202 (Figures 1 & 2a, b).

Figure 11a illustrates the second substrate 200 which is assembled from an interconnecting body 201 (Figure 5a & b) and a dual-branch insert 102 (Figures 8a, b). The second substrate 200 passes bi-directional fluid flow from: the manifold 204 - through the interconnecting body 201- to a component (such as a valve) 206 - through the dual-branch insert 102 - and along the stick 202 (Figures 1 & 2a, b). The second substrate 200 does not have a channel which connects flow directly between the interconnecting body 201 to the dual-branch insert 102. Instead flow between the interconnecting body 201 (Figure 11 a) and the dual-branch insert 102 is only available through the component 206. The interconnecting body 201 and the dual-branch insert 102 have the sell 155 installed within their common counterbores. When the component, here a valve, 206 is closed, flow is blocked between the stick 202 (Figures 1 & 2a, b) and the manifold assembly 204 (Figures 1 & 2a, b).

Turning now to Figures 11b and c is shown an alternate use of the interconnecting body 201 which does not use a factory seal. With this construction, for use in the second level, the interconnecting body 201 is assembled to two single-branch inserts 104 (Figure 7) of other substrates 100, 300 (Figures 9a, b & 12a, b provided later). Such an arrangement provides three ports 182, 414, 182 closely positioned (centerlines spaced 0.30" apart) with a component, here with Figure 11b, a valve, 206 fastened over the ports 182, 414, 182. When the valve 206 is closed over the interconnecting body port 414, and flow is blocked from the manifold 204 (not shown), flow is still allowed through the valve 206 and along the stick 202. Figure 11c shows the valve 206 open and flow allowed between the stick and the manifold assembly 204.

Turning now to Figure 12a is shown a third substrate 300 where a multi-flow body 301 is factory installed with a single-branch insert 104. This substrate 300 is used in the second level as a component substrate. In this assembly, a seal 155 and the single-branch insert first end 176 (Figures 8 a, b) are installed into the multi-flow body 301. Turning now to Figure 12b, centered over and fastened to the top surface 422 of the multi-flow body 301 (Figure 6a) is a component (here a valve) 206. As shown in Figure 12c, when the valve 206 is closed and blocks the top port 436, flow along the stick 202 (Figures 1 & 2a, b) is blocked at the valve 206, but flow from or to the manifold assembly 204 and a portion of the stick 202 is maintained. Gas coming to or from the manifold assembly 204, flows in or out of the stick 202 through the intersecting channel 432, the single-branch insert 104, and down a portion of the stick 202 (Figures 1 & 2a, b), but is blocked from the rest of the stick 202 by the valve 206. Conversely, as shown in Figure 12b, when the valve 206 is open, flow in both directions along the stick 202 (Figures I & 2a, b) and to and from the manifold assembly 204, is allowed.

Turning now to Figure 13, there is shown an exploded view of two substrates 100 connected to each other by fasteners (not shown) and a component (here a valve) 206 connected with fasteners 208 threaded to the flow-through body. Once assembled, the component 206 is positioned over the flow-through body 101first port 158 (Figure 3) of each substrate 100, the single-branch insert second port 182 (Figure 7a & b) of the other substrate 100, the seal 155, the flow-through body second back face 163, and the single-branch insert first end 176 (Figure 7a & b). In this manner, flow is provided through the component 206 by adjacent ports 158/182, spaced 152 a distance of 0.30" between port 158/182 centerlines.

Shown in Figure 14a is an illustration of components 206 connected to substrates 100. When the components 206 are fastened over two substrates 100, the components 206 cover a port of each substrate 158/182, the body undercut second back face 163 (Figure 14B shown later), the insert first end 176, and the factory seal 155 of a substrate 100. However, each component 206 is not centered over the two ports 158/182 as with the previously mentioned three-port arrangement (Figures 11b & c).

Referring to Figure 14b is shown a cross section of components 206 and substrates 100. It can be seen that although the substrates 100 are mechanically connected to each other they do not form a sealed gas path directly between substrates 100. Instead, at assembly with a component 206, the first port 158 of one substrate 100 and a second port 182 of the other

substrate 100 provide flow in and out of the component 206. In this manner, when a series of substrates 100 are connected to components 206, the output of an upstream component 206 becomes the input of a downstream component 206 and flow is directed into net 180-degree turns 154 as it passes through each component 206 and net 180 degree turns 154 as it passes through each substrate 100. It is to be understood that although only one type of substrate 100 was shown any of the substrates 100, 50, 200, 300 may connect in this manner to pass flow along a stick 202.

Referring to Figures 15a & b there is shown an extension 105 used in manifold sections 204 to by-pass a stick 202 (Figure 1) and so no flow interconnection with that stick 202 is desired. Additionally, an extension 105 may be used where no component 206 (Figure 1) is placed at a location and the substrates 100, 200, 300 of a stick 202 (Figure 1) must extend or jump to the next component 206 location (Figure 1). To provide for these occasions, a body 101, 103, 201, 301, an extension 105, and an insert 102, 104, (also 109, 111 shown later) assemble to connect gas flow to: the next component 206, an inlet/outlet fitting 214, or the next stick 202. It is to be appreciated that inserts 102, 104, (also 109 & 111 shown later) and extensions 105 may be of varying lengths to accomplish the connection. As shown in, Figure 15b, the extension 105 has a 0.180" diameter channel 106 running the length to pass flow between two connecting blocks. Returning to Figure 15a, at each end of the extension 105, flow connections are provided by factory seals (not shown) assembled into seal joints (not shown) by authorized personnel.

Referring to Figure 16 is shown a plug 109. A plug connects to a stick end 202 for the purpose of stopping flow. A plug 109 has no channeling but has a 0.29" dia. X 0.030" DP counterbore 110 to mate with a seal 155 (not shown) and block Row coming from a channel in the mating base 101, 103, 201, 301 (not shown).

Shown in Figure 17 is a tube weld insert 111 having a channel 113 which transitions 90-degrees within. The tube weld insert 111 can connect to a base at one end and at the other end, by threads or a weld, connect to an inlet/outlet port 214 such as a VCR couple for input from a gas source or outlet to equipment. Another form of tube weld insert (not shown) provides a straight channel with no bend.

Turning now to Figure 18, the present invention provides for passages 180 in the various bodies 101, 201, 301 which align so that long cartridge heaters can be incorporated into the stick assembly 202 (Figure 1). Heat conductive sleeves 182 are inserted into these

passages 180 to provide thermal coupling between a heating element 184 and the bodies 101, 201, 301 in a completed stick 202 (Figures 1 & 2a, b) or manifold assembly 204 (Figures 1 & 2a, b). In this way, process fluids can be preheated prior to entry into a process chamber.

Turning to Figure 19, is seen a cross-section of a manifold assembly 204 at the end of a stick 202. Constructing a manifold 204 begins with a substrate 100. The manifold substrate 100 connects to a body 201, 301 in the component substrate level to transfer flow between the two levels. At the manifold assembly 204 ends, the substrates 100 may be connected to end inserts (plugs) 109 to block flow or to a tube weld insert 111 which connects to an inlet/outlet fitting 214.

In between the components 206 and the component substrates 100, 200, 300 are placed keepers 207 to aid assembly by insuring proper seal position. For the preferred embodiment, keepers are fabricated from thin (.003" TK) metal foil.

It is to be appreciated that the choice of materials for the various substrates and building-blocks may be other than stainless steel. A variety of different metals and non-metals could be used which would meet the requirements of the present invention. The building-blocks may be machined, forged, sintered, or molded. The factory seal is a metallic seal designed to be crushed into place at assembly. However, it is possible to use seals which are not crush-seated and which are made of a metal, an elastomer, or a combination of metal and elastomer. Much of the determination for material selection centers around the types of fluids used in the fluid panel and their operating temperatures.

When assembled as a gas panel (Figures 1 & 2a, b), the component substrate (second) layer is fastened to components 206 (first layer) above and manifolds 204 (third layer) below. The manifolds 204 are assembled from substrates 100 and connect to the second layer of component substrates through the use of other substrate designs 200, 300. In addition, attached to the component substrate layer are the brackets 210 that attach to a support structure such as a mounting plate 212. In this manner, the component substrate or second level is bracketed to a support structure 212 below and fastens to components 206 above while fastened below the component substrate level are the manifolds 204.

Figures 20a & b illustrate ail alternate embodiment of the present invention. With the preferred embodiment, one overall dimension of a fluid panel was primarily defined by the length of the sticks. With this alternate approach, a fluid panel can be assembled in, which that length is reduced by folding the sticks 202 into a U-shape around a shortened support

structure 220. The component's 206 functioning end (having the in and out ports) always faces the support structure 220 so that components 206 on one side of the support structure 220 are opposing components 206 on the other side of the support structure 220. With the exception of the mass flow controllers, the components are not shown in Figures 20a & b to more clearly show the design aspects of the "U" shape. The sticks 202 are attached with brackets 210 to both sides of the support structure 220. At the fold or bend, a bridge substrate 460 is used to connect the channels of the sticks 202 on one side of the support structure 220 to their counterpart channels on the opposite side of the support structure 220 thereby maintaining the fluid connections. Within a stick 202, a fluid may still travel the same distance as non-folded designs but since the sticks 202 are curved back on themselves in a U-shape, the overall fluid panel dimension that was driven by stick 202 length is reduced. In this manner, it is possible to package a fluid panel system into more demanding or specialized dimensional environments.

A portion of channeling made up of tubes assembled into a curved shape is used as a flex-joint 440. This section of the overall stick channeling has been added to provide dimensional flexibility within the stick 202 to reduce the necessity for tighter tolerancing needed to bridge a long space with a rigid block or substrate.

Turning now to Figures 21a & b is shown another alternate embodiment, an L-shaped fluid panel design. With this design, the support structuring 472 allows the sticks to make a 90-degree turn or bend. The sticks 202 are not complete, many of the components 206 are missing so that the repeating pattern of some of the substrates 50, 100, 200 can be clearly seen. Again, a bridge substrate 470 is needed to complete the turn. As with the previous alternate embodiment (Figures 20a & b), the stick path length for the fluid is maintained while tailoring the overall gas panel dimensions to meet specific size requirements. As with the previous alternate embodiment, a flex-joint 440 may be used within a stick 202.

It should be appreciated that a fluid panel of the present invention is not required to maintain a particular identity of components or substrates on a single plane or level. It is entirely possible for any of the 1-4 levels mentioned to follow any path. A "U", "L", or even a "Z" (not shown) shape is possible but not inclusive to meet dimensional requirements. It is also possible with an alternate embodiment to have one or more individual sticks turning or interspersed within several levels such that no ascertainable level exists.

Referring now to Figure 22 is shown simplified cross-sections of the various bases, inserts and bridges. This Figure provides a convenient illustration of fluid flow through most of the basic building blocks in the present invention.

Referring now to Figure 23 there are seen a set of markings that are placed along the sides of the various bodies 101, 103, 201, 301 to show the location of channels. The markings provide information on the channel positions and thus the gas flow when the bodies 101, 103, 201, 301 are coupled to the inserts 102, 104, 109, 111.

We claim:

1. A fluid panel subassembly comprising:

a component;

a substrate comprising

a substrate seal;

a body; and

an insert wherein

the body is fastened to the insert with the seal therein and the component fastened to the body such that the component is positioned over the substrate seal.

2. The fluid panel subassembly of claim 1, further comprising: the body has a undercut, wherein the undercut has a back surface; the insert has an end. such that; when the insert end is positioned within the body undercut, the component superposes the undercut back surface and the insert end.

3. The fluid panel subassembly of claim 2, further comprising:

the insert has a fluid channel therein;

the channel is connected to two ports;

an inlet/outlet fitting is connected to the first port; and

the component is connected to the second port.

4. The fluid panel subassembly of claim 2, further comprising:

the insert has a fluid channel therein;

the channel is connected to two ports;

an inlet/outlet fitting is connected to the first port; and

the base is connected to the second port.

5. A fluid panel subassembly comprising:

a body comprising:

an undercut, wherein is located a port:

an insert comprising:

an end having a port, such that

when assembled to the body, the insert end is positioned within the body undercut, the insert port is adjacent to the body port with a substrate seal in between; and

a component is assembled to the body such that the component is positioned over the body port and the substrate seal.

6. A fluid panel subassembly comprising:

a component; a body comprising:

a first undercut having a first backface;

a second undercut having a second backface;

such that when the body is assembled to the component, the component is positioned over the first backface and the second backface.

7. A fluid panel subassembly comprising:

two substrates each comprising:

a body comprising:

a first undercut, and a second undercut;

an insert comprising:

a first end, and a second end;

wherein the insert first end is assembled to the body second undercut with a substrate seal positioned between;

one substrate body first undercut and the other substrate insert second end are joined; and

a component is connected to the other substrate body, so as to be positioned over the substrate sell and the one substrate insert second end.

8. The fluid panel subassembly of claim 7, further comprising:

the body first undercuts have through holes;

the insert second ends have a bottom surface;

wherein, pins extend from the bottom surface, and the pins of the one substrate insert is positioned into the body undercut through holes of the other substrate when the substrates are assembled together.

9. A fluid panel subassembly comprising;

an interconnecting body comprising:

a top channel at a top surface port of a top surface;

two bottom channels at two bottom surface ports;

wherein the two bottom channels intercept the top channel within the body.

10. The fluid panel subassembly of claim 9, further comprising:

two inserts, each comprising:

a top surface having a port;

the interconnecting body further comprising:

two undercuts;

and the two inserts are assembled into the undercuts and a component is assembled to the interconnecting body;

such that each insert top surface port and the interconnecting body top surface port are superposed by the component.

11. The fluid panel subassembly as in claim 10, further comprising: two substrates each comprising:

an insert;

a body; with

a substrate seal therein; and

the substrates connected to the interconnecting body bottom surface ports, such that a continuous fluid flow path exists between the component and all the inserts.

12. A fluid panel subassembly comprising:

a multi-flow body comprising:

a top channel connected to a top surface at a top port,

two bottom channels connected to a bottom surface at two bottom surface ports, wherein the two bottom channels intercept the top channel within the multi-flow body,

a first undercut having a first undercut back surface normal to the top surface;

first port on the first undercut back surface; and

first channel at the first port intersecting the top channel.

13. A fluid panel subassembly of claim 12, further comprising:

two substrates each comprising:

a body, an insert with a substrate seal therein;

wherein the multi-flow body top surface is connected to a component, the substrates are connected to the bottom surface ports, and the component is positioned over one of the substrate seals.

14. A fluid panel subassembly of claim 13, further comprising:

two inserts, each having a first end and a second end;

the first insert second end is connected to the second undercut;

the second insert first end is connected to the first undercut with a substrate seal therein, such that the component superposes the two substrate seals.

15. A fluid panel assembly comprising:

a plurality of substrates each comprising;

a body;

an insert; and

a substrate seal therein;

a plurality of components and a portion of the plurality of substrates are assembled into a plurality of sticks;

another portion of the plurality of substrates are assembled into a plurality of manifolds; and

the manifolds are connected to the sticks, such that the plurality of components superpose at least one substrate seal.

16. A fluid panel subassembly comprising:

a stick comprising;

a plurality of components;

a plurality of substrates; and

a bridge substrate, such that when assembled, at least one of the plurality of components opposes at least one of the other portion of the plurality of components.

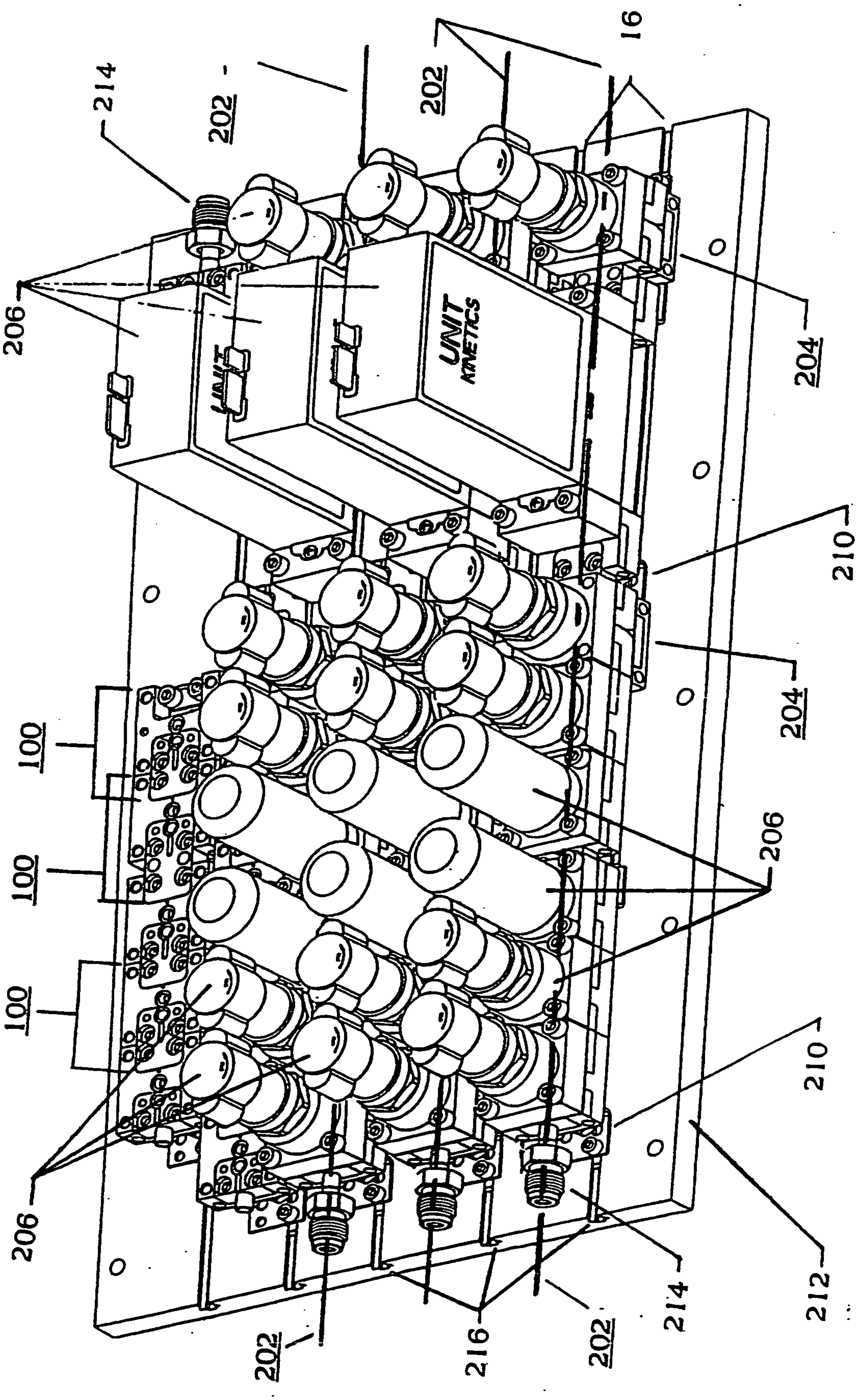
17. A fluid panel subassembly comprising:

a support structure;

a stick comprising;

a plurality of components;

a plurality of substrates; and a bridge substrate, such that when assembled, at least one of the plurality of components is on one side of the support structure with at least one of the other portion of the plurality of components on the opposite side of the support structure.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UNIT KINETICS
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216
202

Figure 1

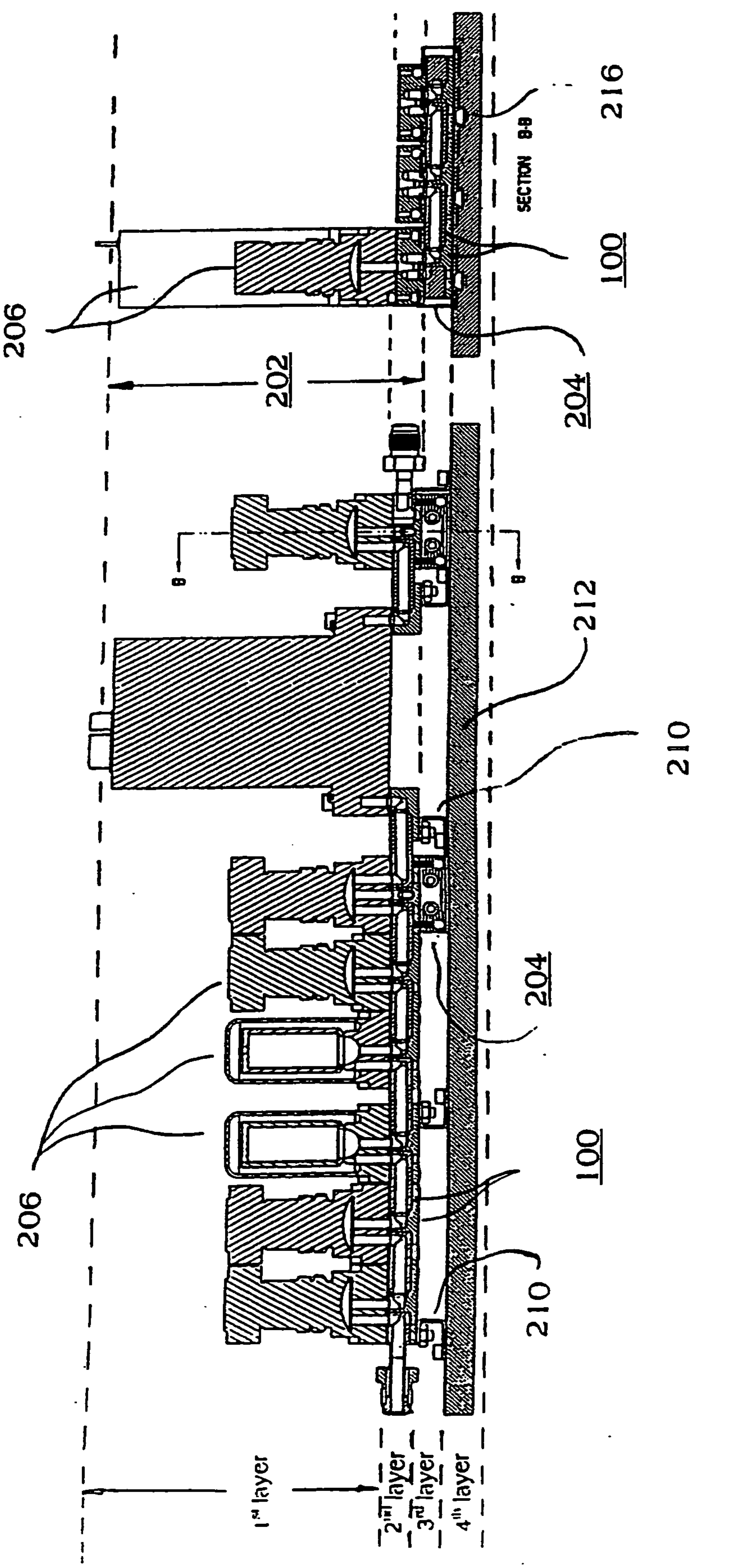

Figure 2b

Figure 2a

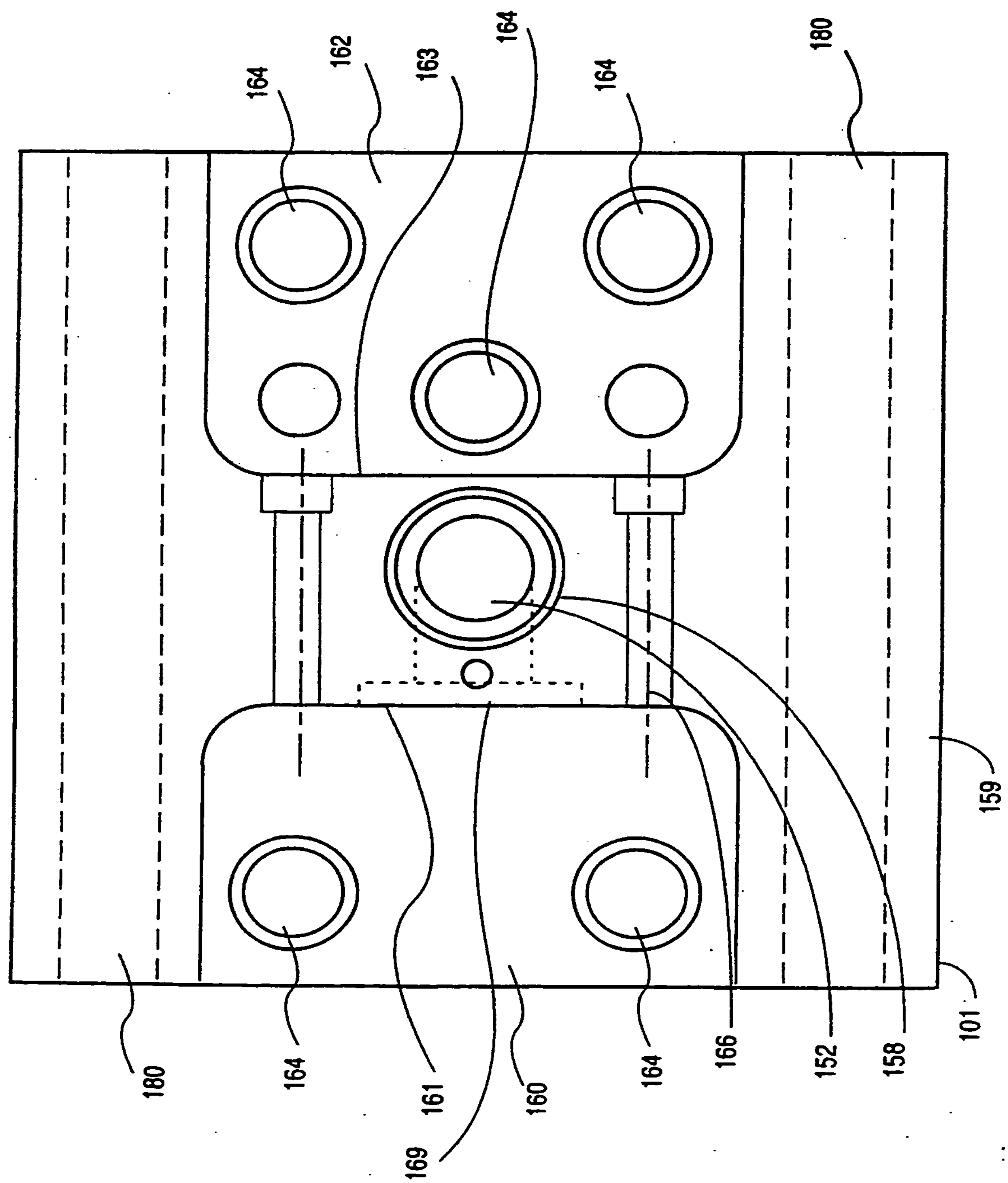
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FIG. 3

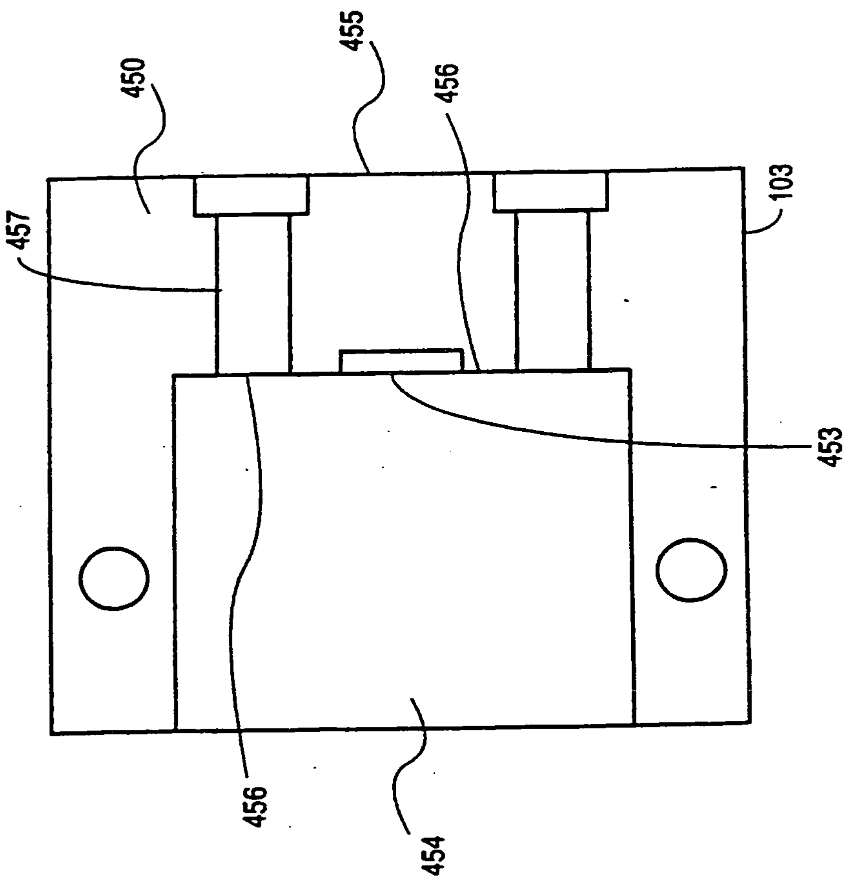

FIG. 4

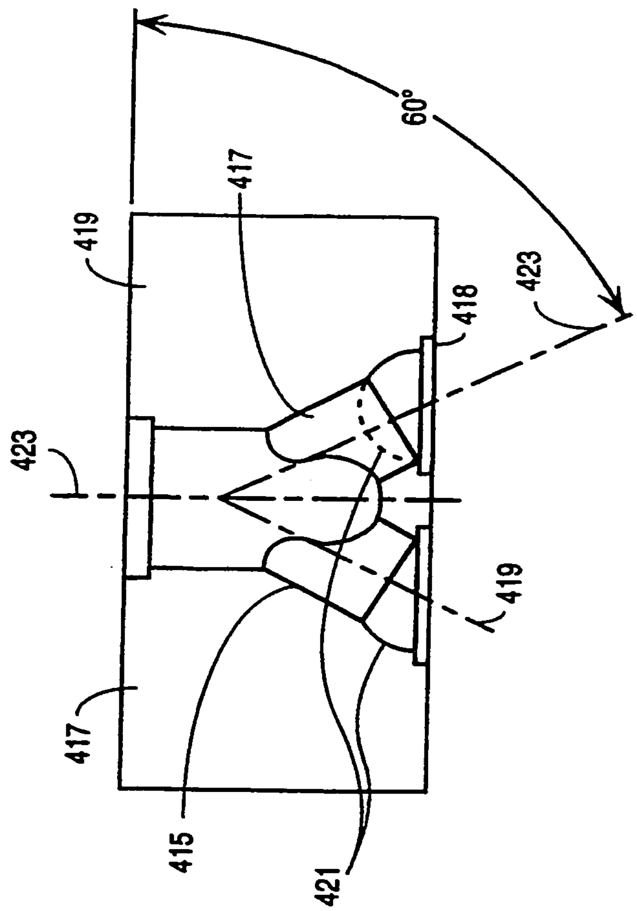

FIG. 5a

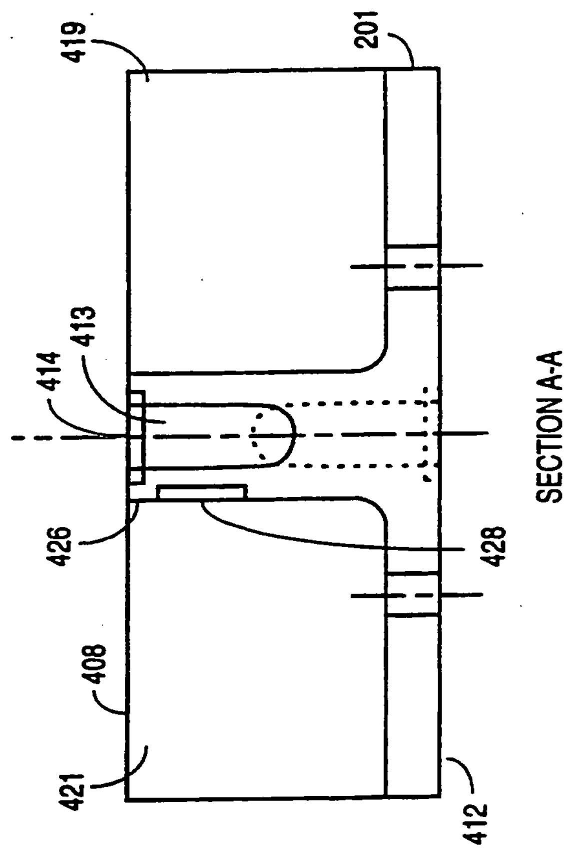

FIG. 5b

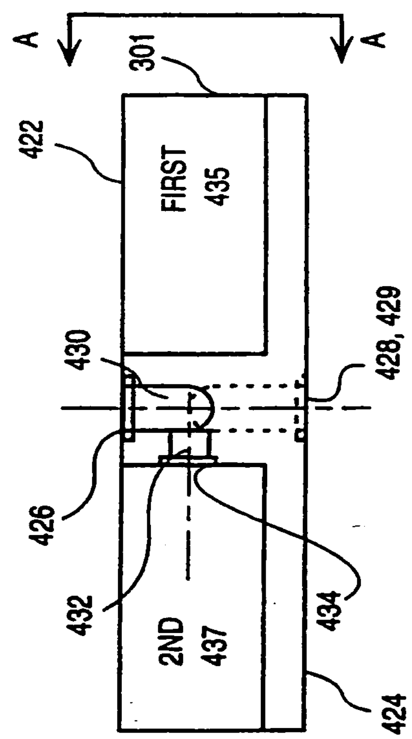

FIG. 6a

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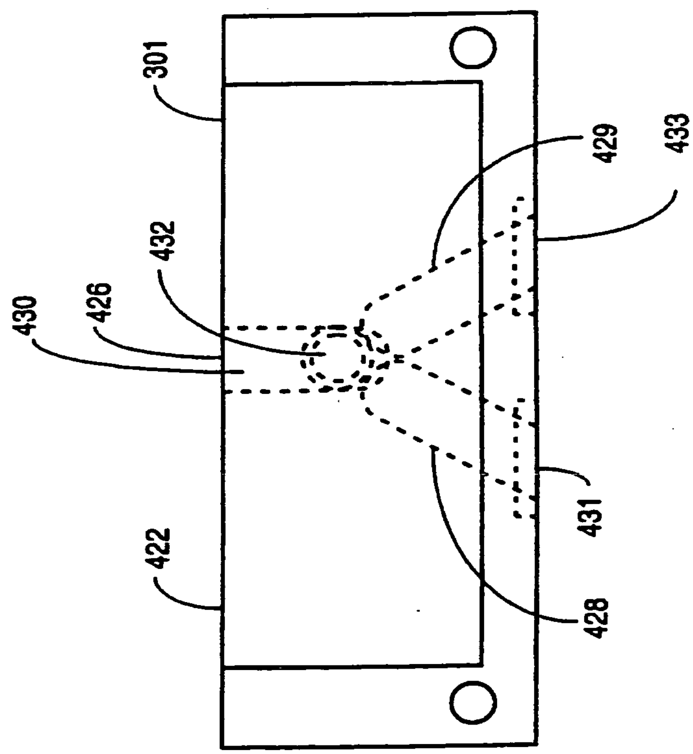

SECTION A-A

FIG. 6b

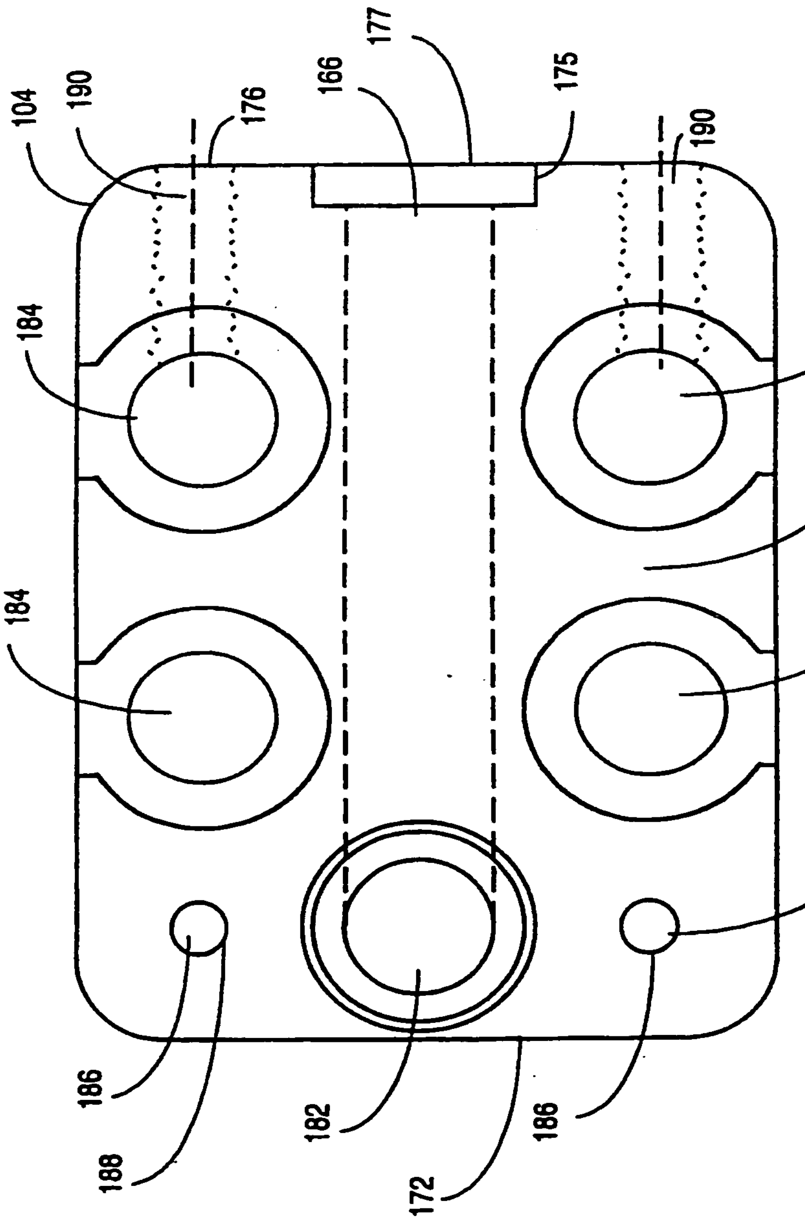
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FIG. 7a

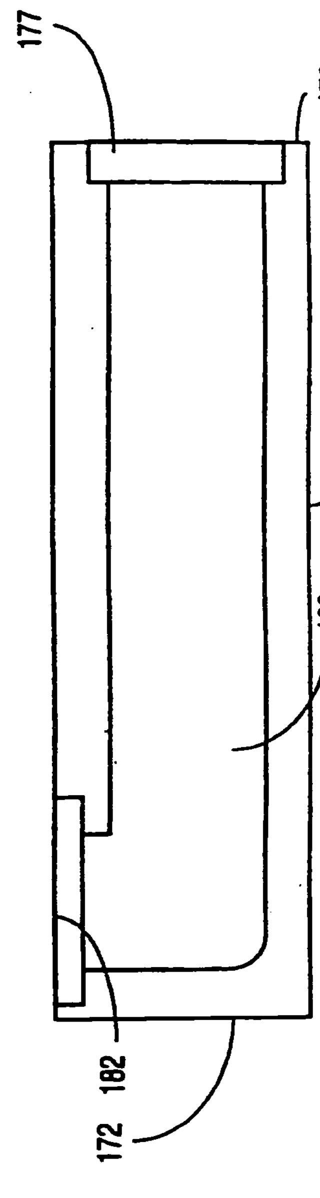
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FIG. 7b

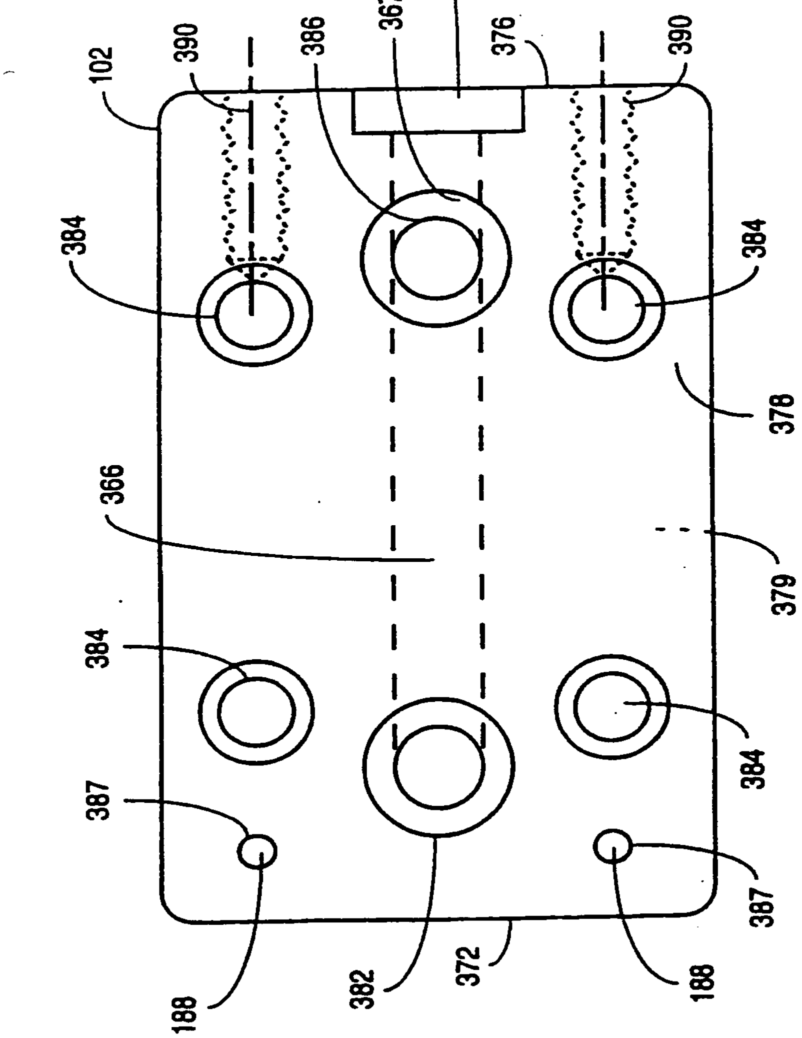
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FIG. 8a

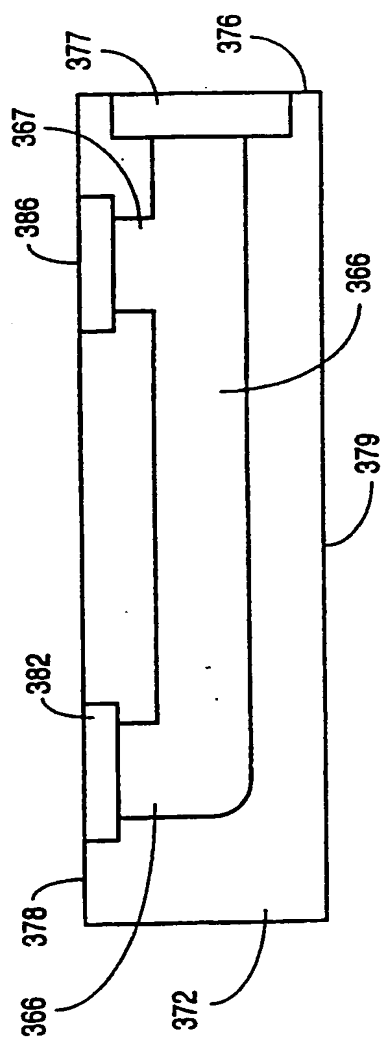
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FIG. 8b

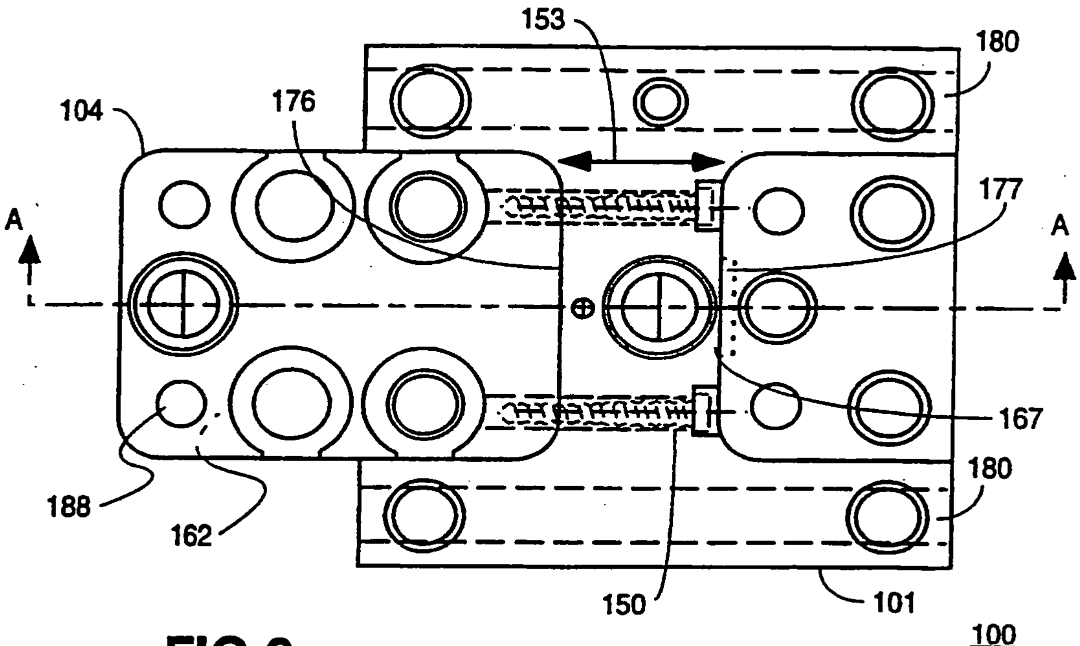
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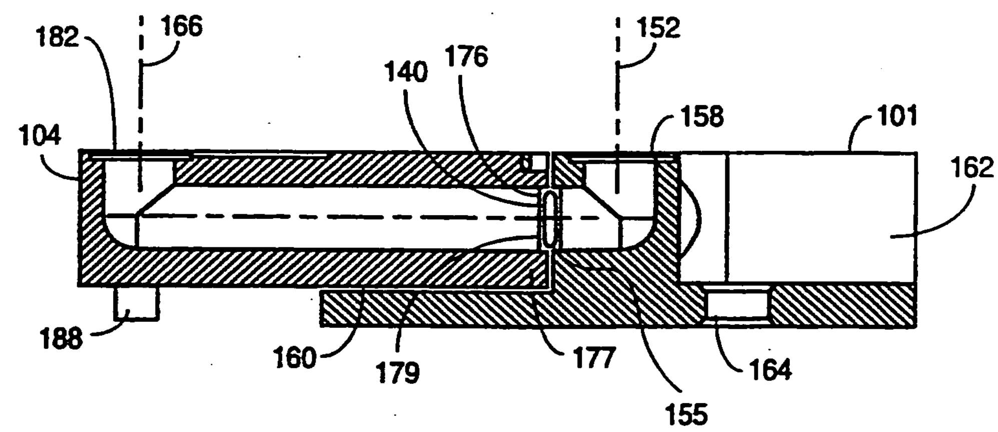
FIG. 9a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155
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100

FIG. 9b

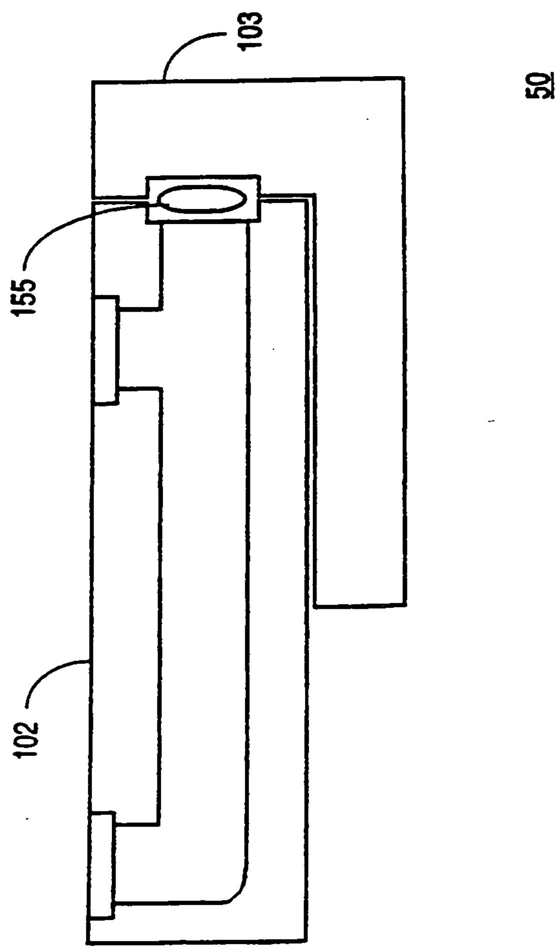


FIG. 10

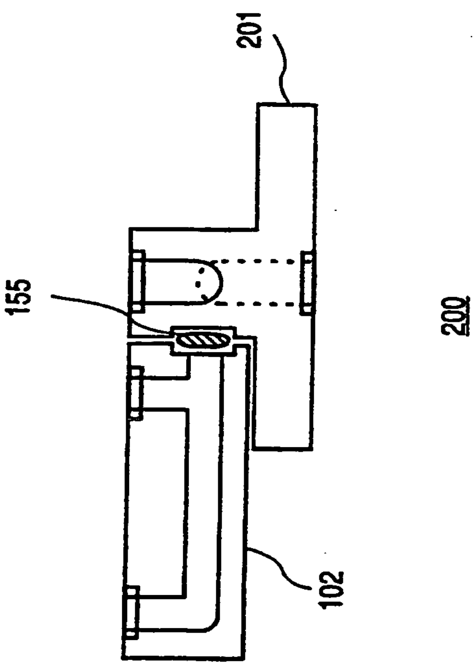


FIG. 11a

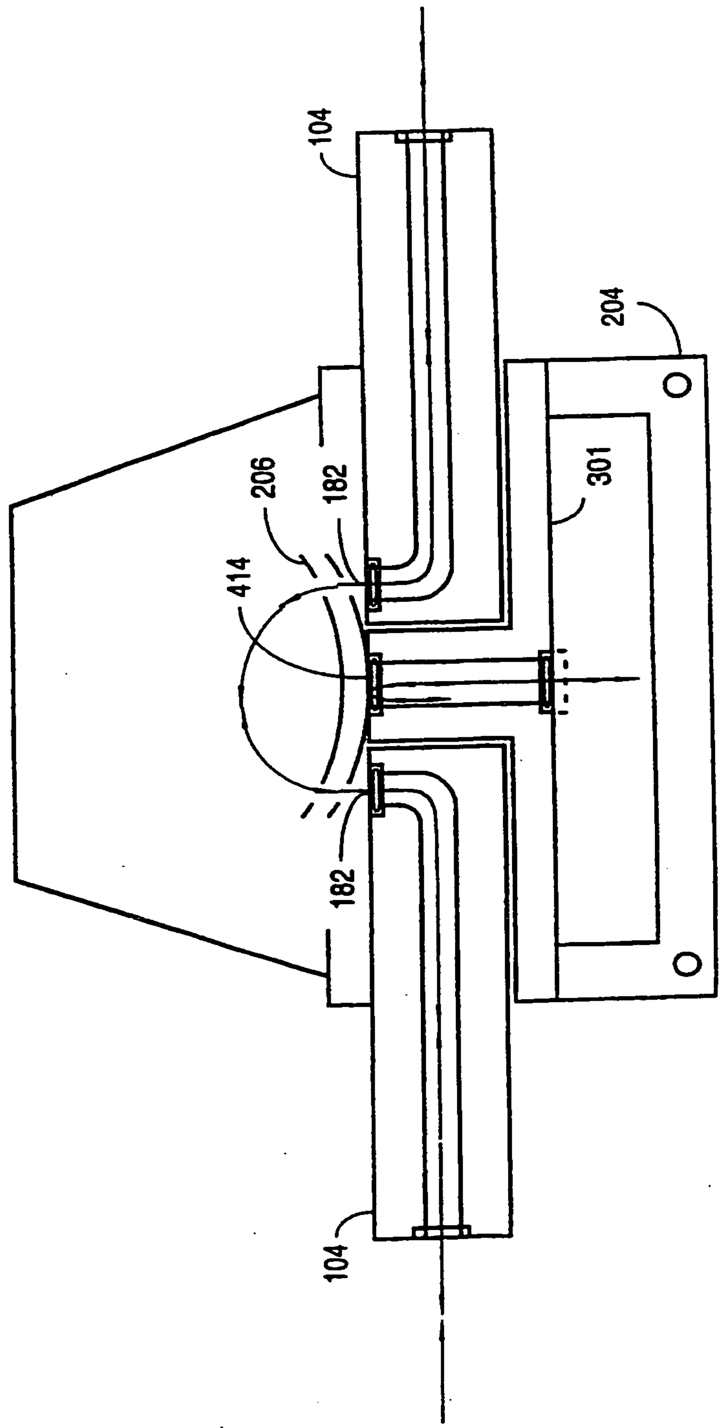


FIG. 11b

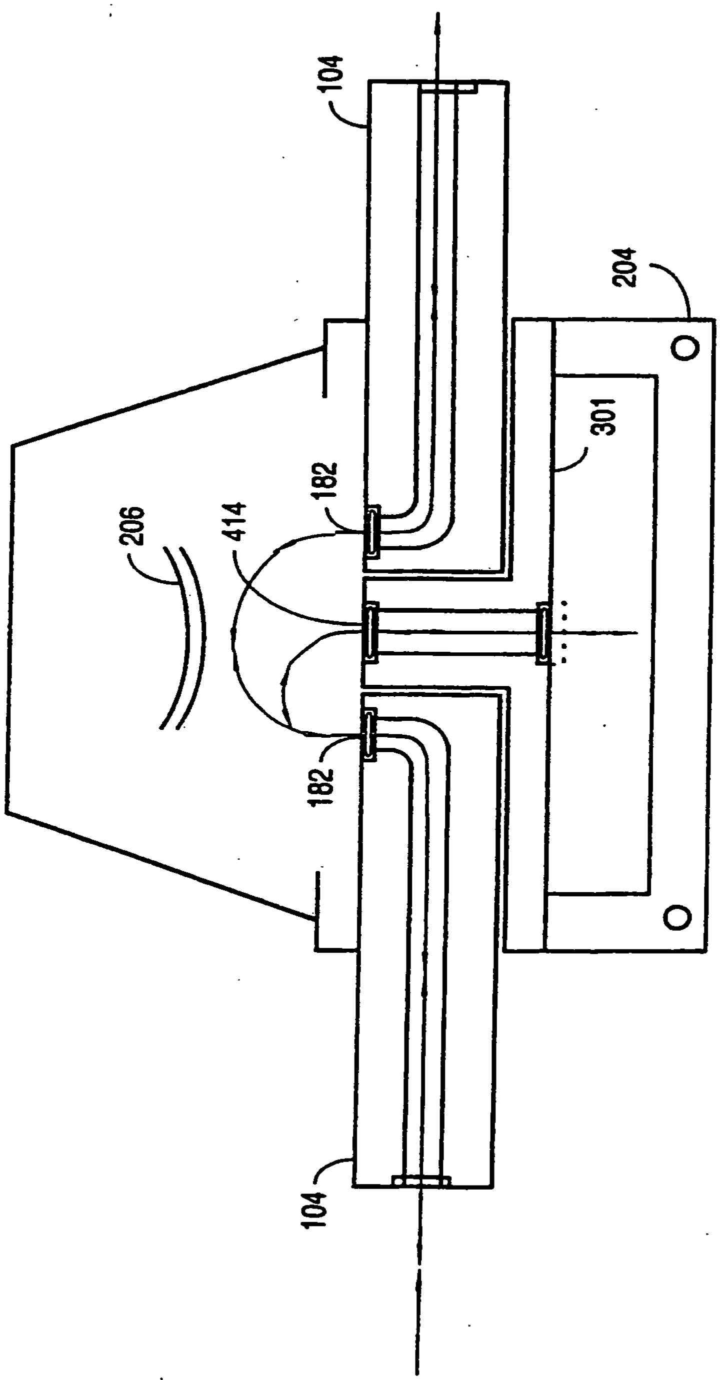
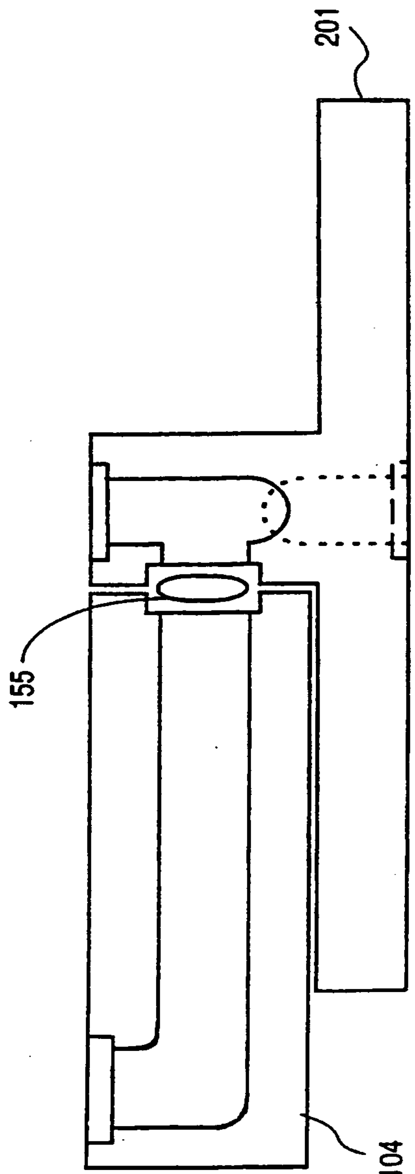


FIG. 11c



200

FIG. 12a

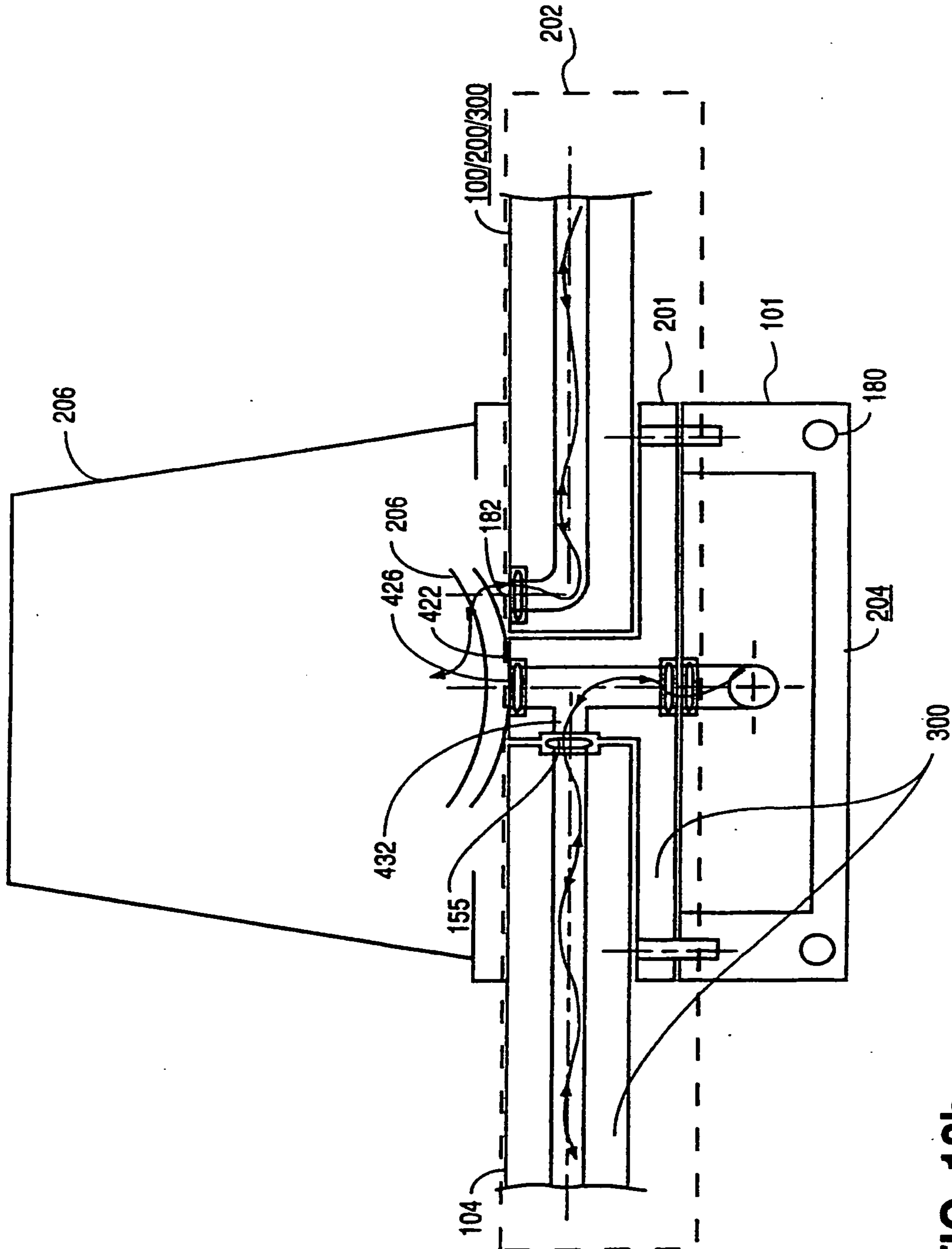

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FIG. 12b

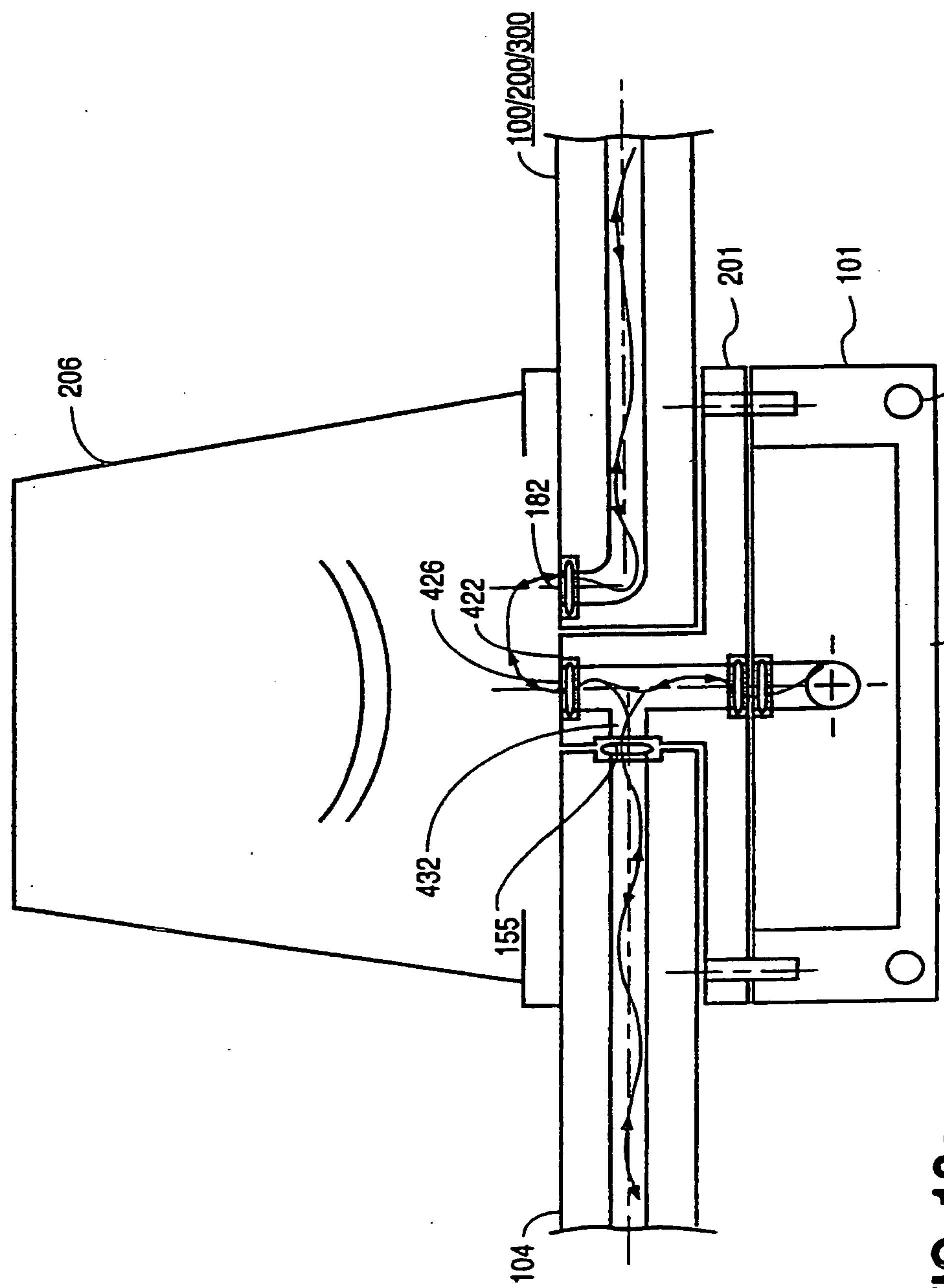

FIG. 12c

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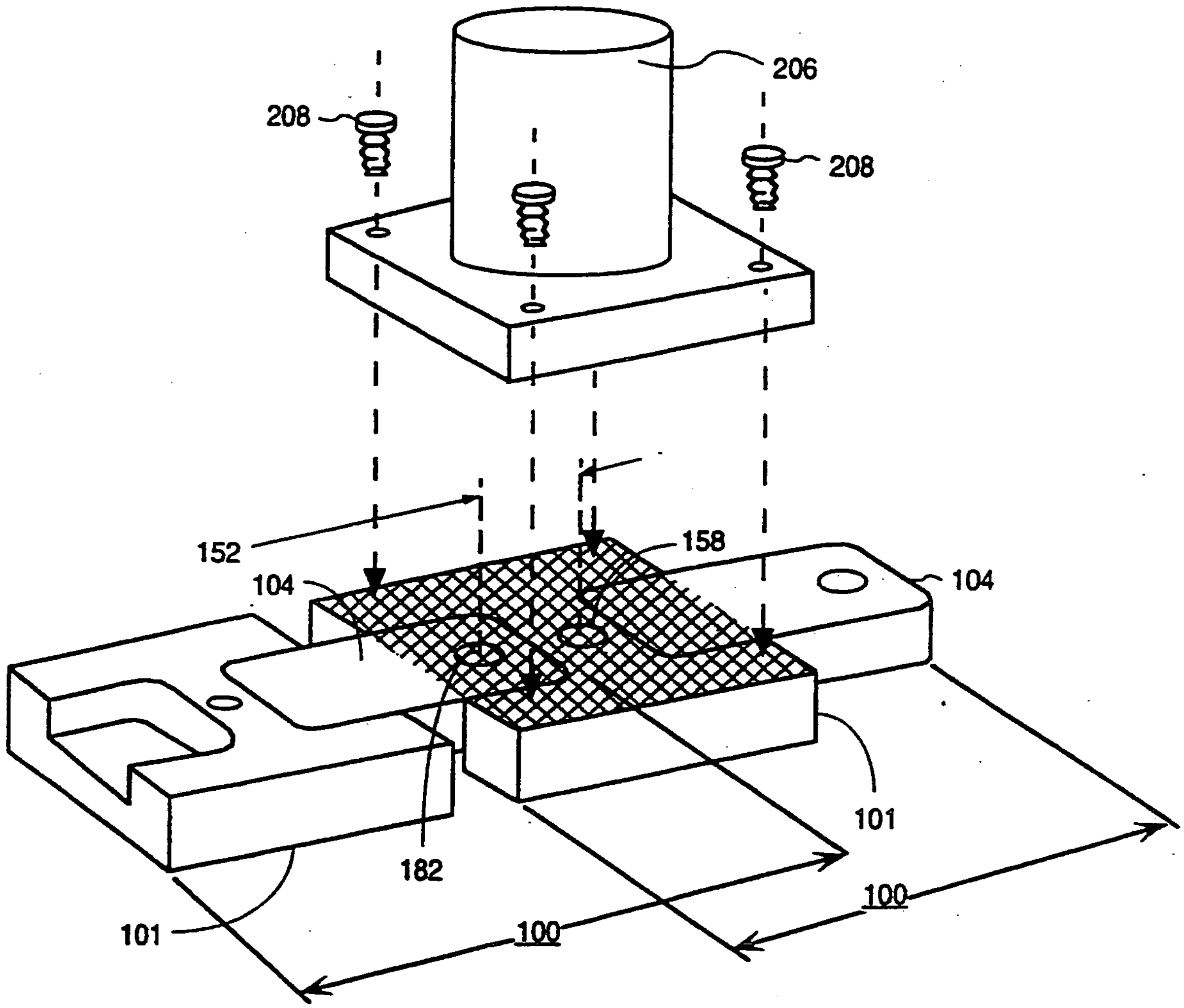

FIG. 13

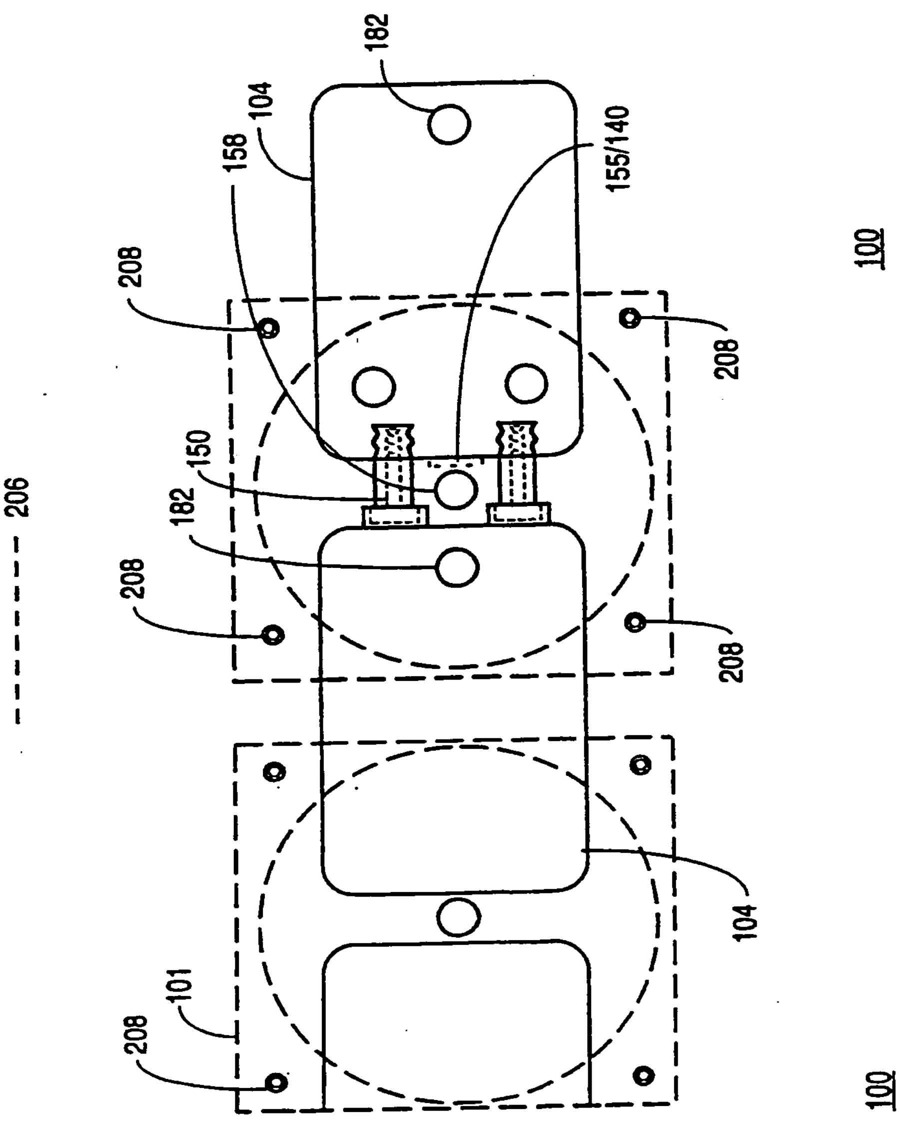
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FIG.14a

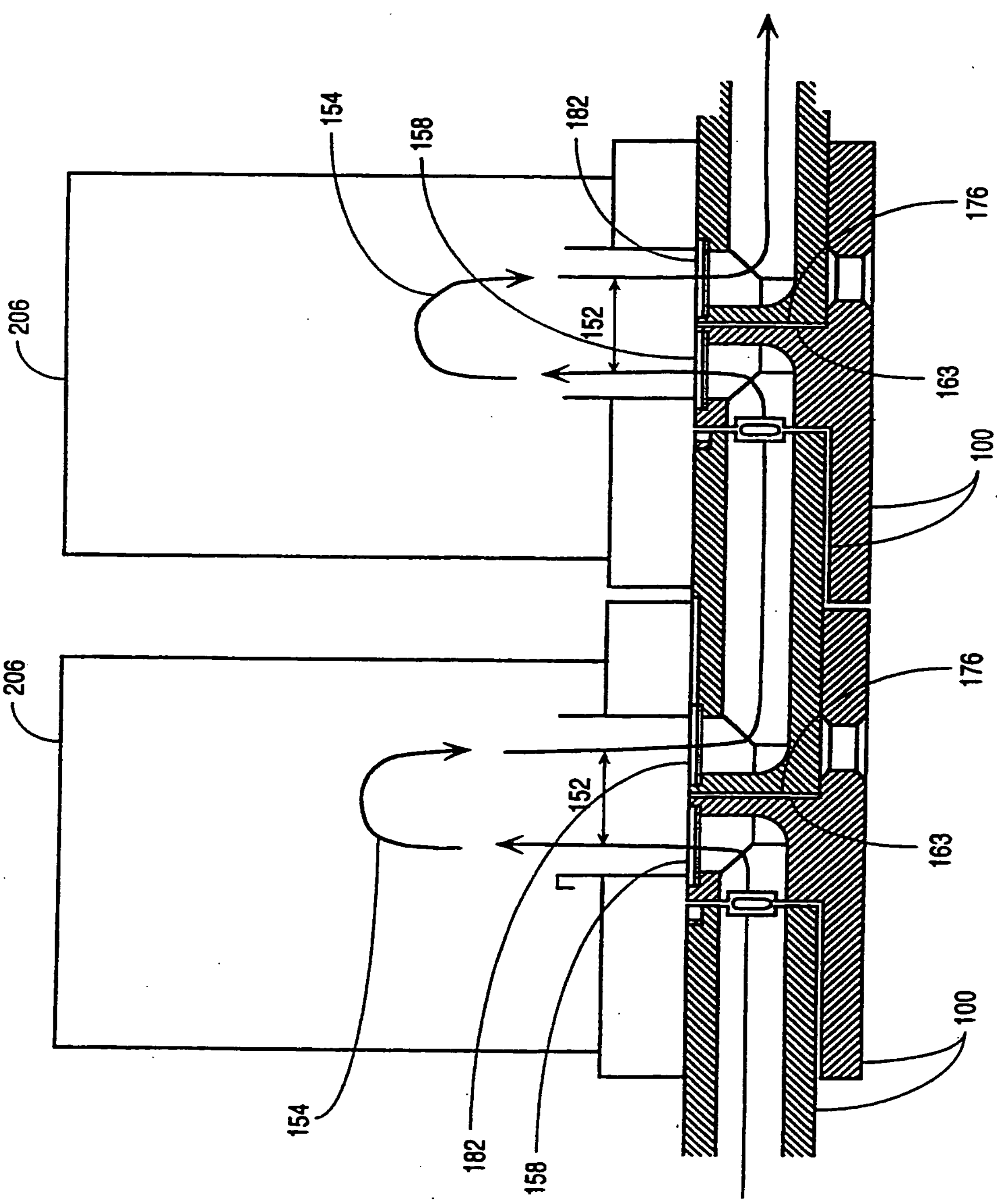

FIG. 14b

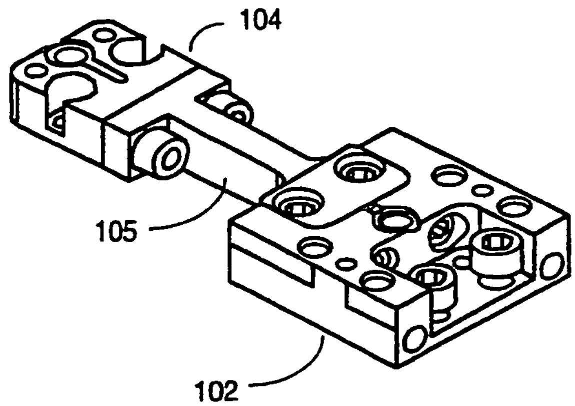

FIG. 15a

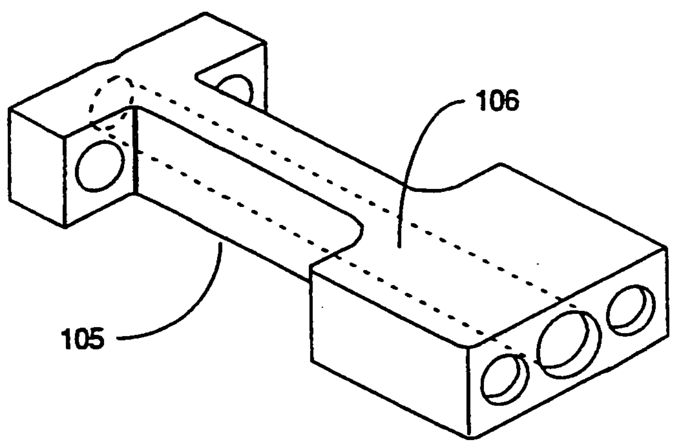

FIG. 15b

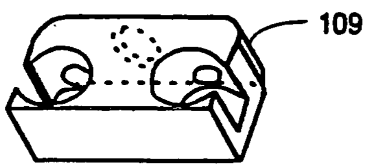

FIG. 16

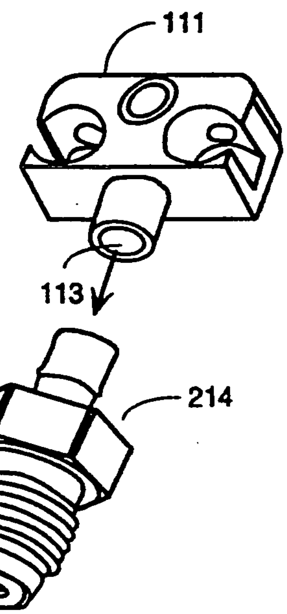

FIG. 17

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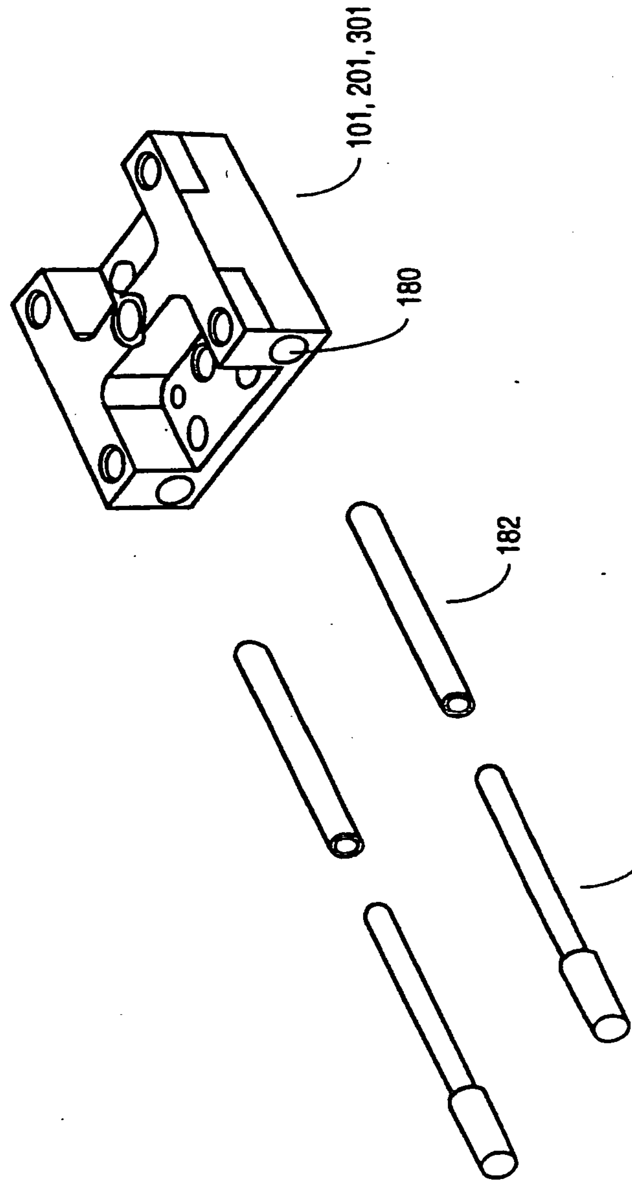

FIG. 18

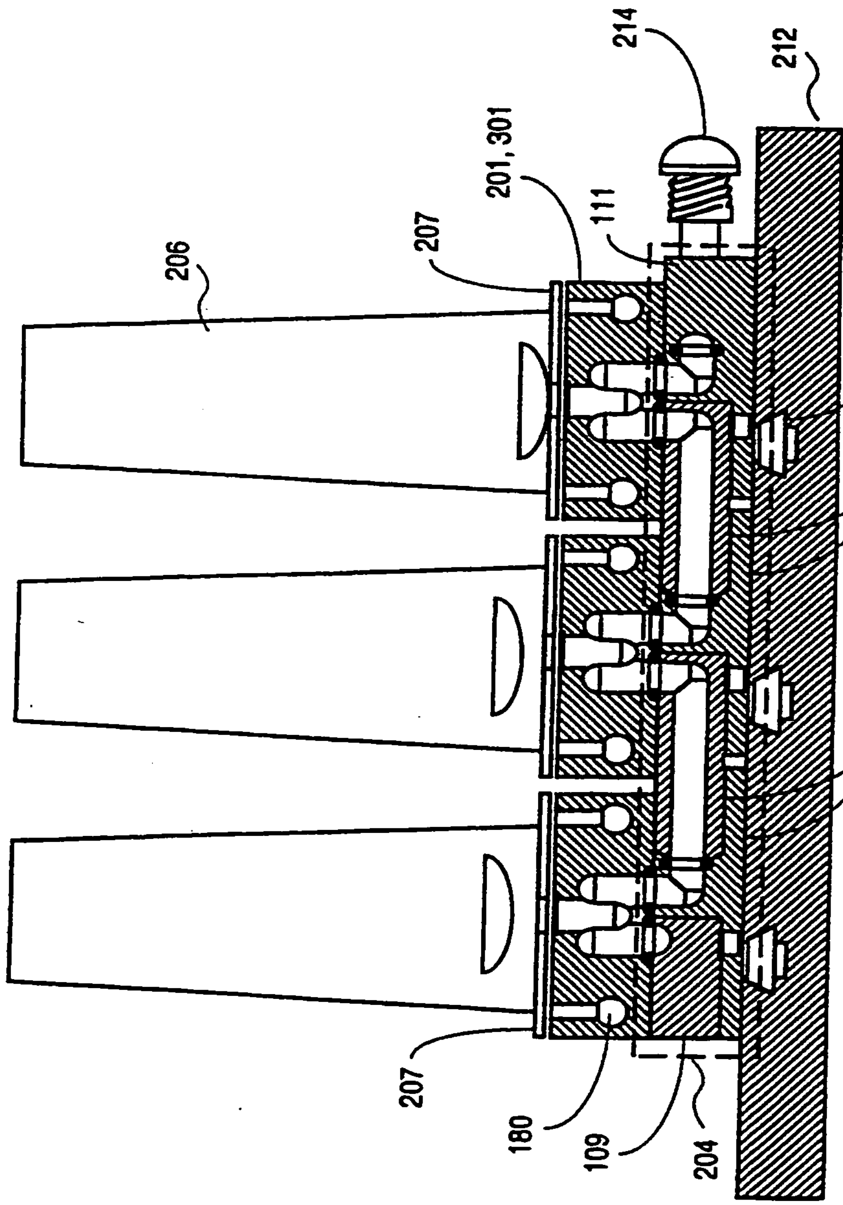

FIG. 19

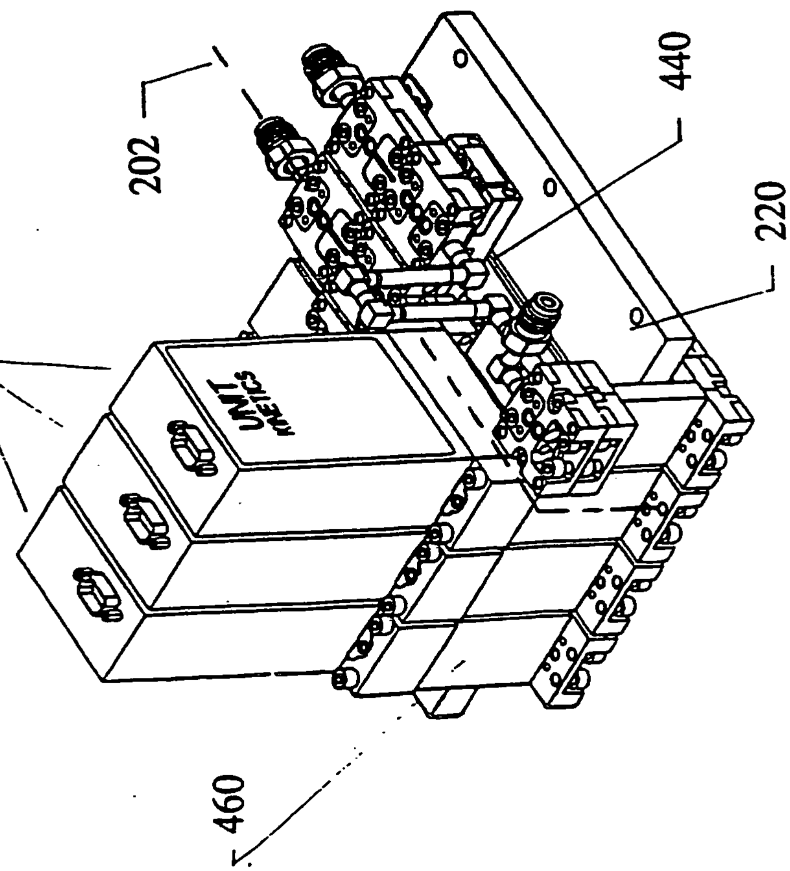

Figure 20a

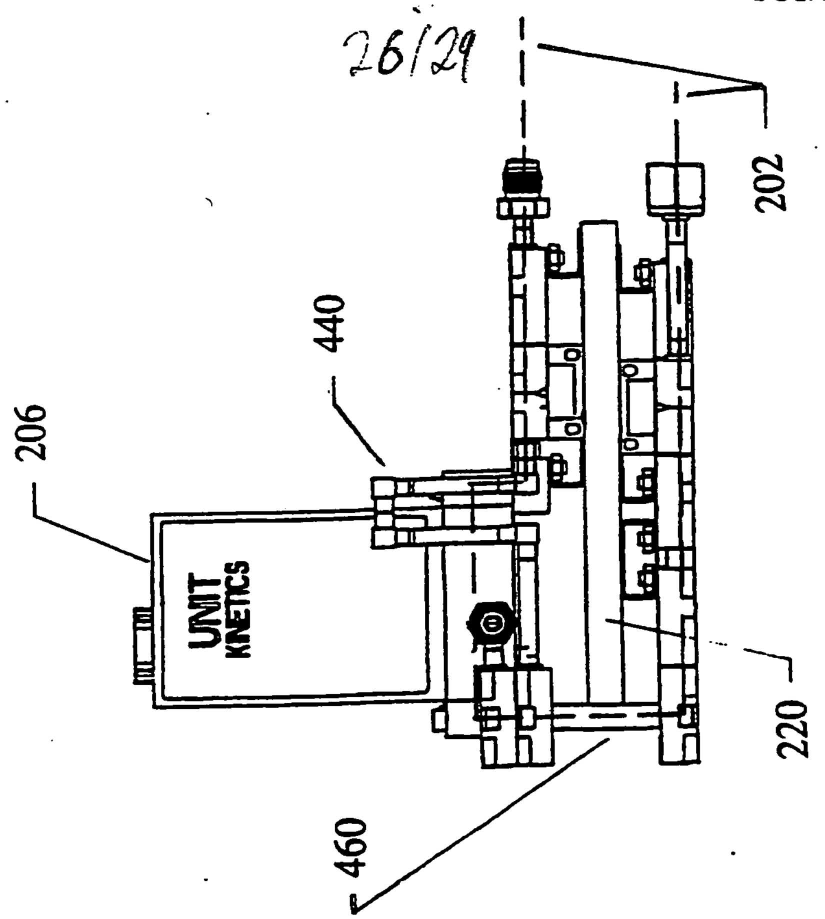

Figure 20b

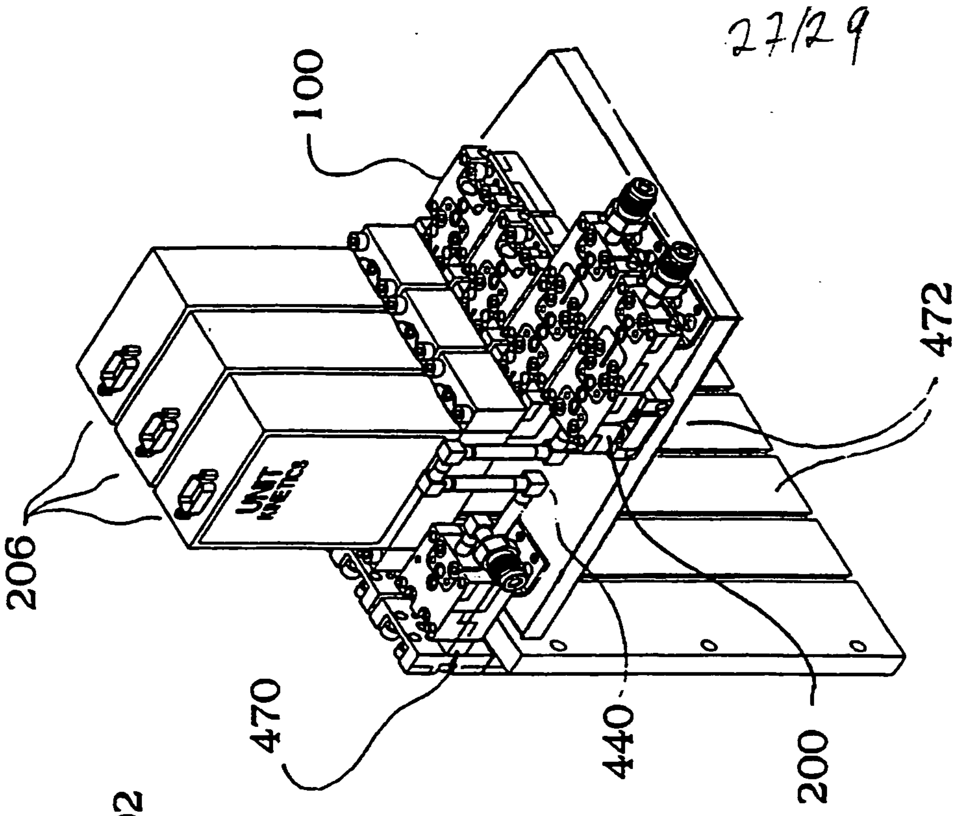

Figure 21b

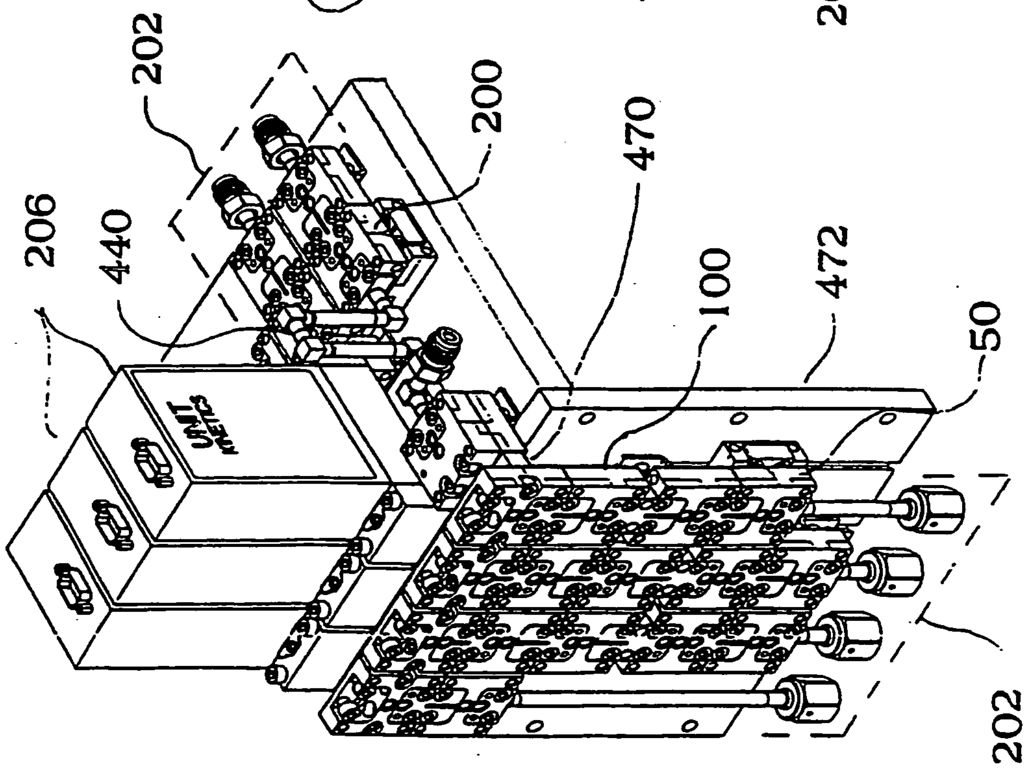

Figure 21a

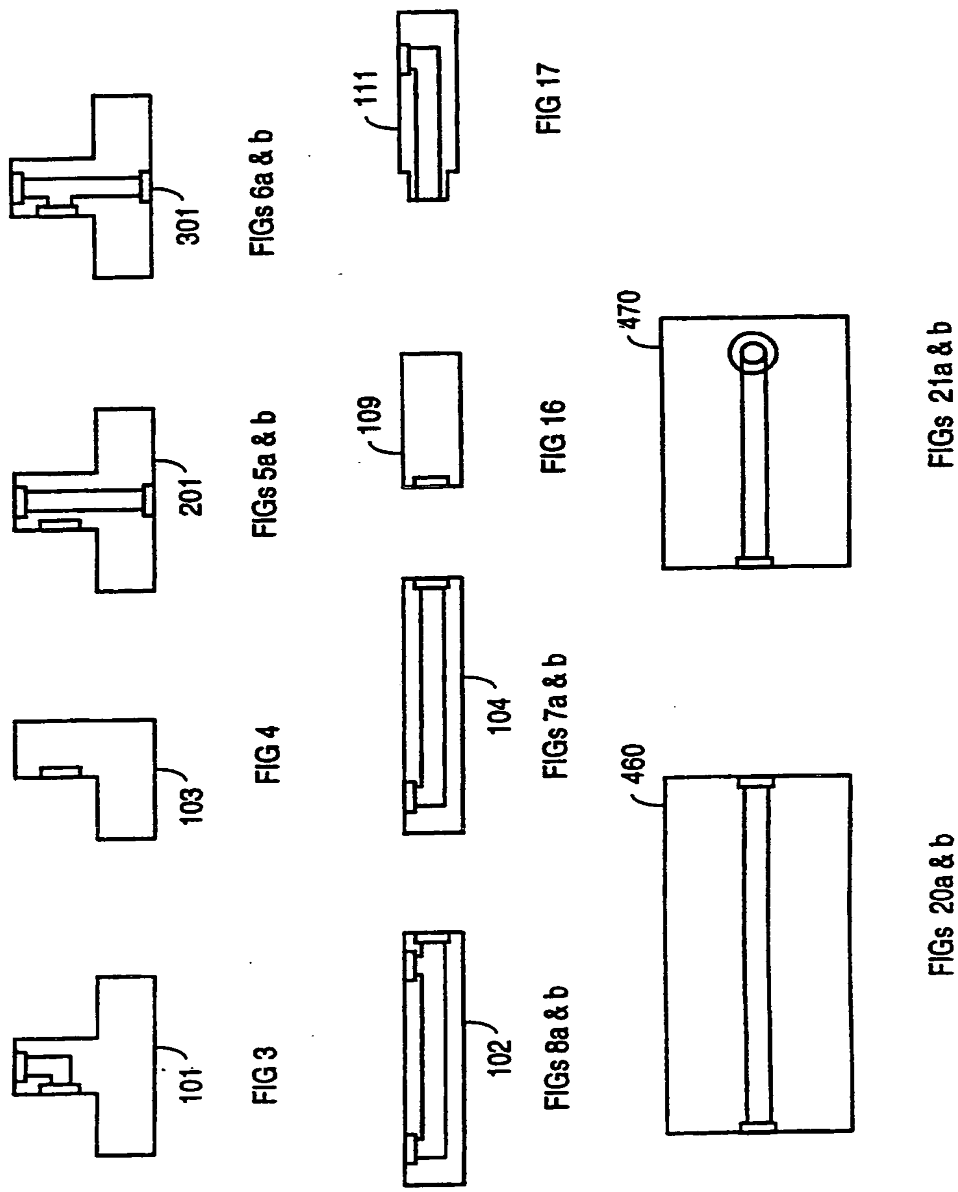
FIGs 6a & b
301
FIG 17
111
FIGs 5a & b
201
FIG 16
109
FIGs 21a & b
470
FIG 4
103
FIGs 7a & b
104
460
FIGs 20a & b
FIG 3
101
FIGs 8a & b
102

FIG. 22

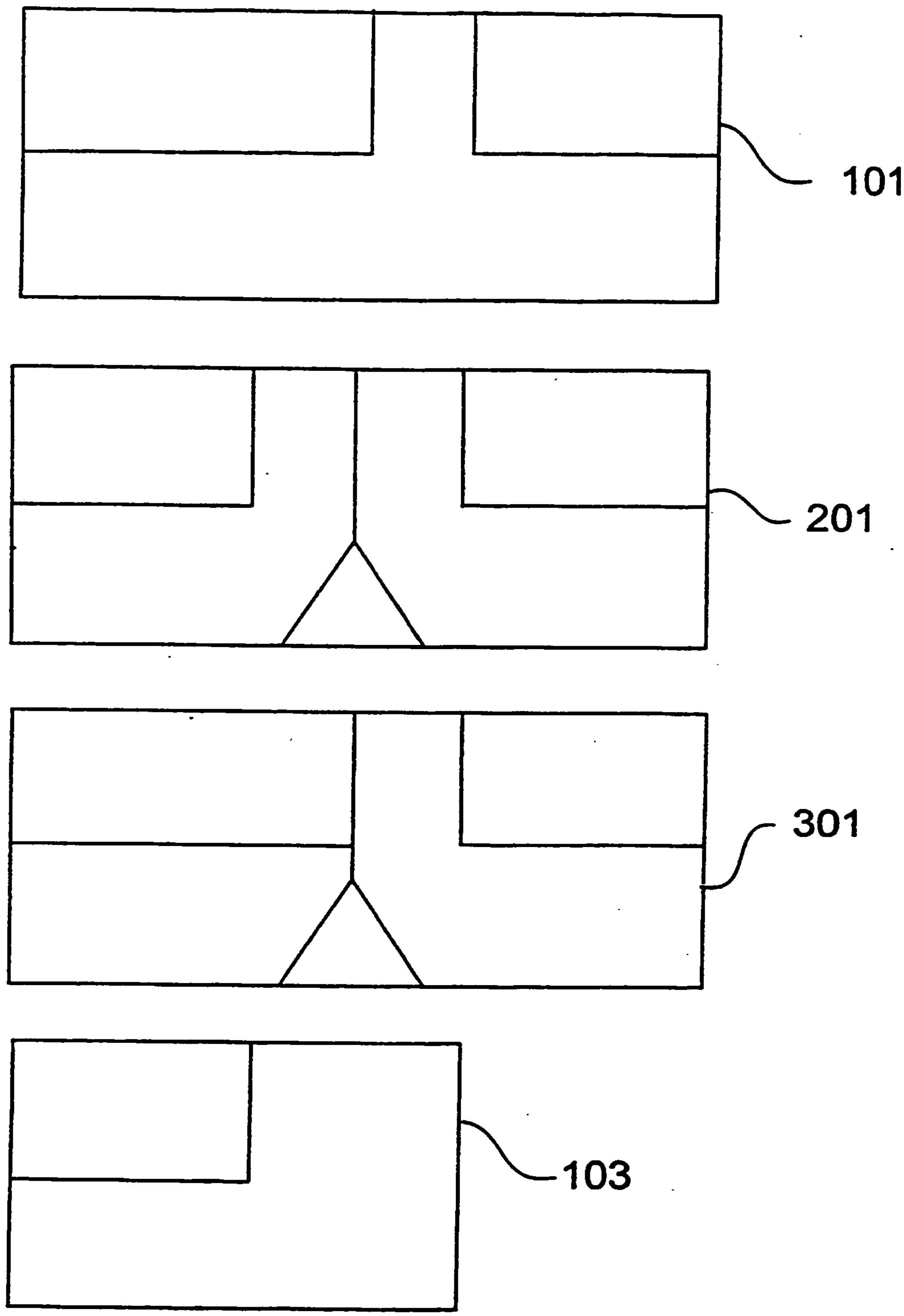

Figure 23

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09/456,226 6 December 1999 (06.12.1999) US

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(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: VU, Kim, Ngoc [US/US]; 20451 Via Marwah, Yorba Linda, CA 92886 (US).

(74) Agent: LANDO, Peter, C.; Wolf, Greenfield & Sacks, P.C., 600 Atlantic Avenue, Boston, MA 02210 (US).

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(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

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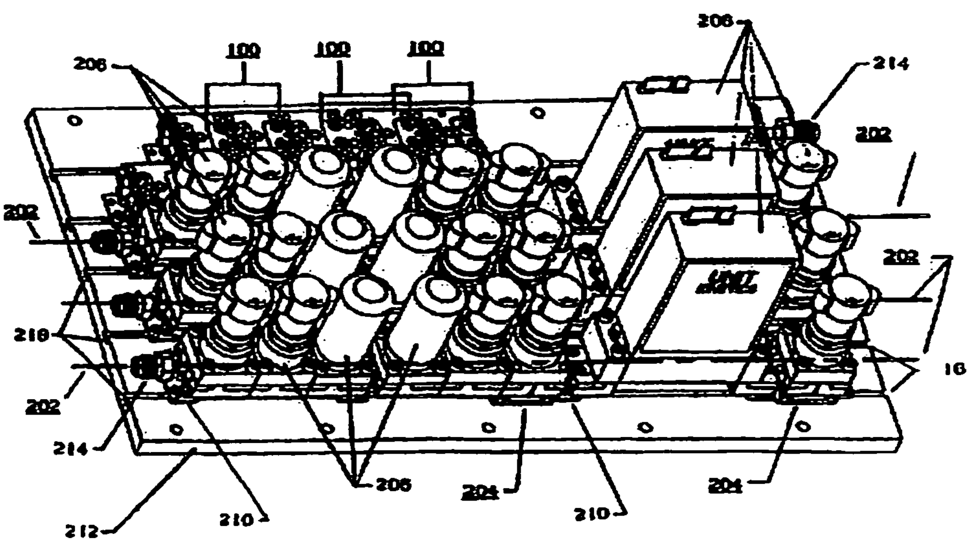
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: DISTRIBUTION SYSTEM OF MODULAR PROCESS LINES



(57) Abstract: A fluid panel subassembly comprising, a component (206); a substrate seal (155), a body (201), and an insert (104); wherein the body is fastened to the insert to form a substrate with the substrate seal therein, and the component is fastened to the body such that, the component is positioned over the substrate seal.

WO 01/42694 A3

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 00/42589

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F16K27/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F16K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 1999, no. 05, 31 May 1999 (1999-05-31) & JP 11 051226 A (CKD CORP), 26 February 1999 (1999-02-26) abstract	9
A	US 5 836 355 A (ELLIOT BRENT D ET AL) 17 November 1998 (1998-11-17) abstract; figures 1-7	1,5-7, 12,15-17
A	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 02, 29 February 2000 (2000-02-29) & JP 11 311355 A (CKD CORP), 9 November 1999 (1999-11-09) abstract figures 1-38	1,5-7, 12,15-17

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
5 October 2001	17/10/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Bilo, E

INTERNATIONAL SEARCH REPORT

Inte .ional Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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